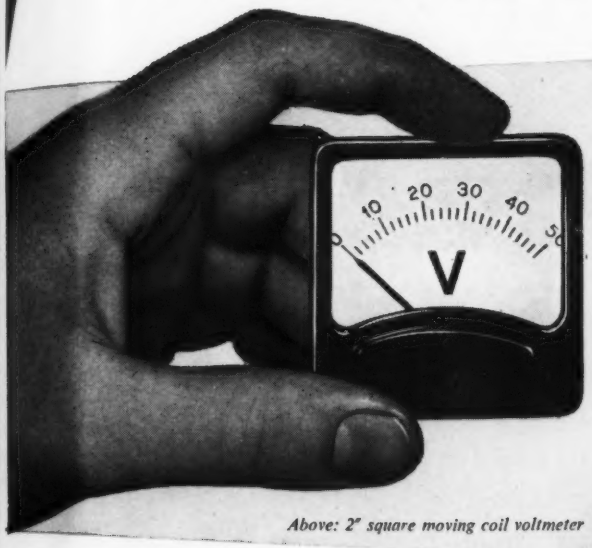
Circle 3 for further information

A COMPREHENSIVE RANGE OF
"Miniature" Instruments



Above: 2" square moving coil voltmeter

★ **DESIGNED TO HARMONISE WITH ALL MODERN ELECTRONIC EQUIPMENT**

★ **FIXINGS CONFORM TO ACCEPTED PRACTICE**

★ **PRICES ARE HIGHLY COMPETITIVE**

For utmost reliability all 'ENGLISH ELECTRIC' miniature instruments have been designed with a higher-than-normal torque/weight ratio in combination with lower power consumption. All types have been successfully subjected to the following tests:

RESISTANCE TO IMPACT SHOCK OF 200g in any plane.

VIBRATION FATIGUE TEST—two million cycles at peak resonant frequency.

OSCILLATORY TEST—up to one million operations.

Above: 3"x 4" rectangular absorption wattmeter

SPECIFICATIONS B.S. 89–1954 and other International Specifications.

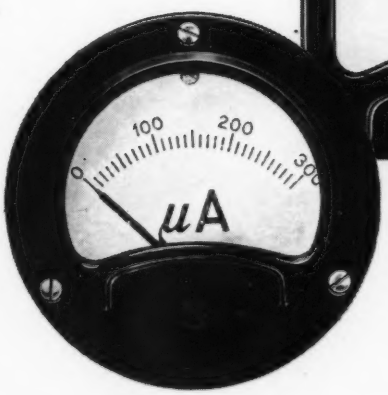
TYPES

Moving coil for D.C. applications.
Rectifier moving coil for A.F. applications.
Thermo-couple operated moving coil for R.F. applications.

SIZES

Square: 2", 2½" and 3½" nominal scale length.
Round: 2½" and 3½" nominal scale length.
Rectangular: 5"x 6" or 3"x 4" nominal case size.

Design registrations pending.



Left: 2½" round moving coil microammeter

Over 50 standard ranges in any of the seven case types.

Delivery ex stock for standard ranges.

Non-standard ranges to customer's specification within 21 days.

Literature available on request to The ENGLISH ELECTRIC Company Ltd., Instrument Department, Stafford.

'ENGLISH ELECTRIC'

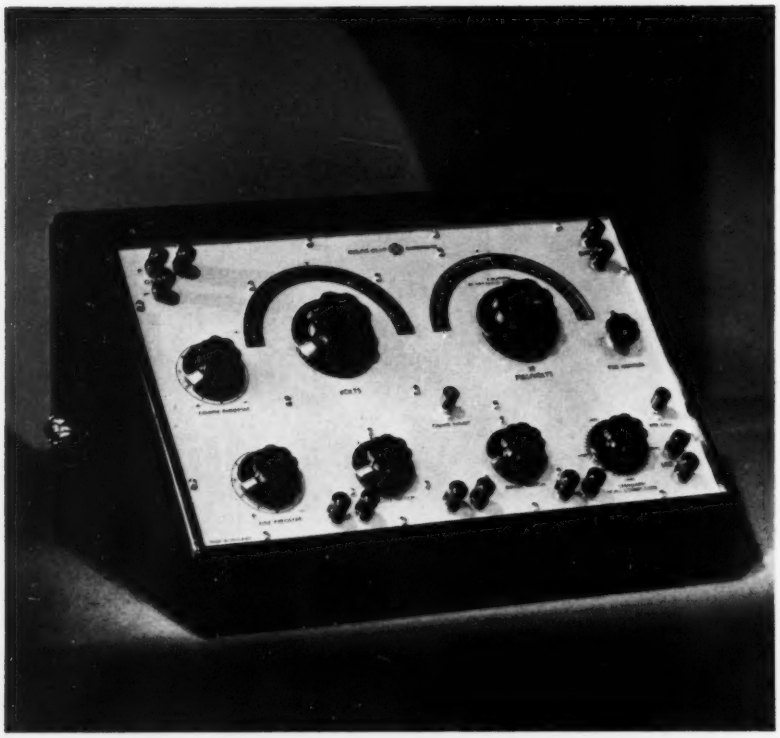
THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Meter, Relay and Instrument Division, Stafford

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

INS.43A

Circle 4 for further information



Pye Universal Precision Potentiometer
Cat. No. 7565

PYE POTENTIOMETERS

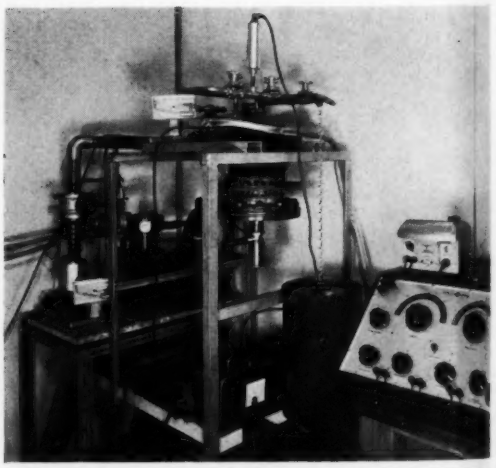
Where voltage measurements of the highest accuracy are required Pye Potentiometers are the ideal choice.

The Pye Precision Vernier Potentiometer (Cat. No. 7568) is intended for use with thermocouples for precise temperature measurement or for the accurate measurements of resistance: it can be used for calibrating potentiometers and standardising currents for electrical measuring instruments. This instrument is ideally suited for submission to the National Physical Laboratories for certification as a laboratory reference standard. No slidewires are used in the measuring circuit and the switches employed are specially designed for long life and very low e.m.f. effects. The range is 0 to 1·901 V and the accuracy is ±0·002%.

The Pye Universal Precision Potentiometer (Cat. No. 7565), illustrated above, employs an ingenious slidewire device which incorporates the tapper key. This virtually eliminates wear on the slidewire, which maintains its linearity through its very long life. The range is 0 to 1·75 V with an accuracy of ±0·02%.

For compactness, robustness and convenience in use, the Pye Portable Potentiometer (Cat. No. 7569/P) stands supreme. All facilities, such as galvanometer, standard cell and accumulator (or dry battery) are built-in. The range is 0 to 1·8 V. Multipliers of 0·1 and 0·01 convert each scale division into 100 μV and 10 μV respectively. Accuracy ±0·1% or ±1 slidewire division.

SCIENTIFIC PYE INSTRUMENTS



The above apparatus featuring the Pye Universal Potentiometer and Scalamp Galvanometer is being used by the Atomic Energy Division of the General Electric Co. Ltd. to carry out research into uranium fuel elements.

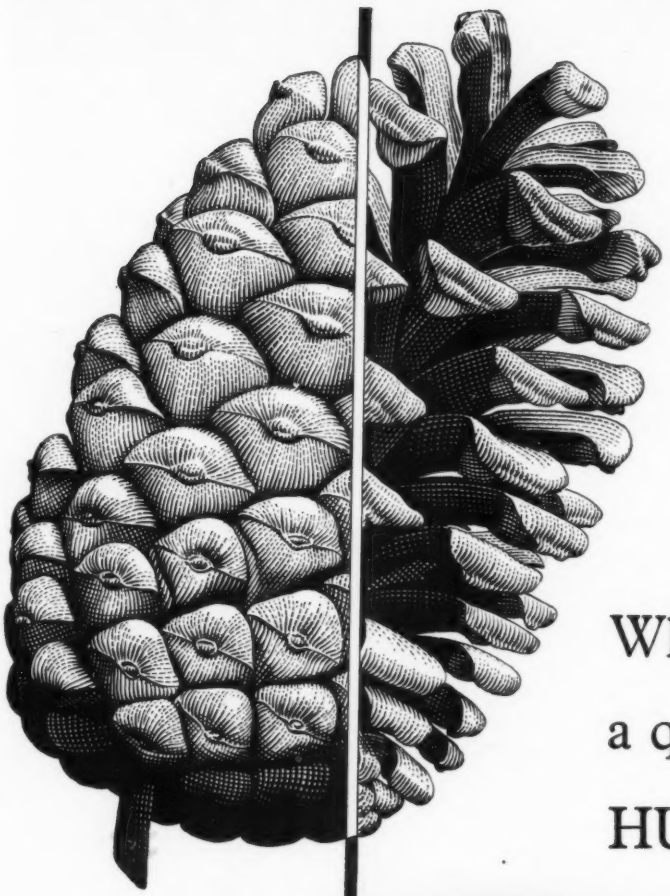
Please write for full details of these instruments and of any accessories, such as galvanometers, shunts, cells, etc. that may be required.

Immediate delivery of a limited quantity is available.

W. G. PYE & CO., LTD., GRANTA WORKS CAMBRIDGE

Tel: Cambridge 54411 *Grams: Pye, Cambridge*

Circle 5 for further information



When it's
a question of
HUMIDITY

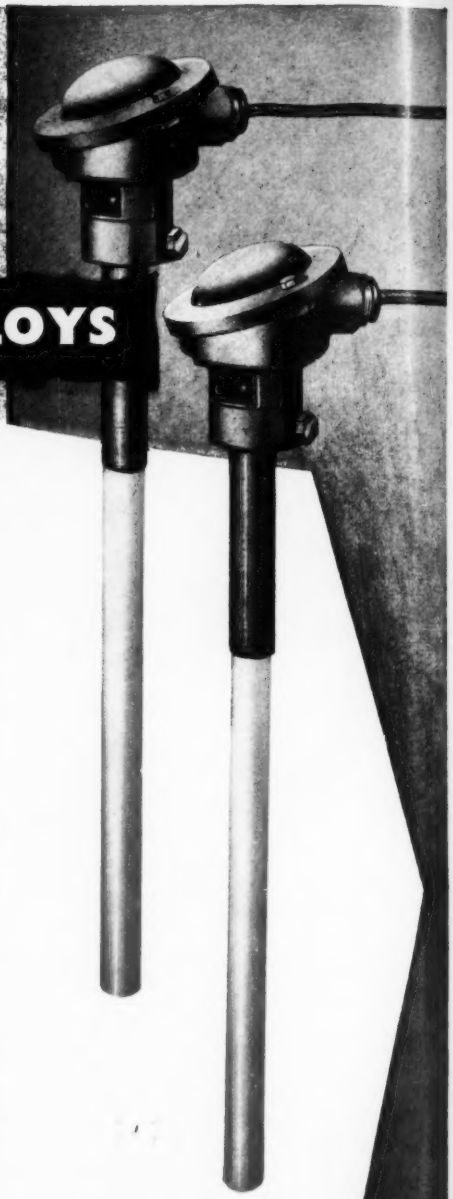
consult . . .

NEGRETTI & ZAMBRA

Manufacturers of instruments for the indication, recording, controlling of:— Temperature, pressure, liquid level, volume. Specific gravity, humidity, etc. Also meteorological and aircraft instruments.

NEGRETTI & ZAMBRA LIMITED,
122 REGENT STREET, LONDON, W.1
Telephone: REGent 3406. Telegrams: Negretti, Piccy, London.
BRANCHES: Birmingham, Cardiff, Glasgow, Leeds, Manchester, Nottingham.
Agents or Subsidiaries in most countries.

Circle 6 for further information



High Temperature

THERMOCOUPLE ALLOYS

"Ni-Cr (plus) v/s Ni-Al (minus)"

Conforming to B.S. 1827:1952

The Thermo-electric properties of the Nickel-Chromium/ Nickel-Aluminium Alloys "Ni-Cr(Plus)" and "Ni-Al (Minus)", are in strict conformity with those stated in the American National Bureau of Standards Circular 561, and British Standard Institution Reference Tables for Thermocouples, B.S. 1827:1952.

For Compensating Cables and Extension Leads in Civil and Military Aircraft, "Ni-Cr(Plus)"/"Ni-Al(Minus)" Wires have Ministry of Supply (Air) type approval, for Cables manufactured to Specifications EL. 1705 and 1632.

LOW TEMPERATURE THERMOCOUPLE WIRES:—

CONSTANTAN v PURE IRON
CONSTANTAN v H.C. COPPER

We manufacture a special quality of Thermocouple iron and are able to supply matched wires in the Iron v Constantan combination to meet customers' varied Thermal-EMF requirements. Furthermore, and of infinitely greater importance, we are able to guarantee the reproducibility of those thermo-electric properties.

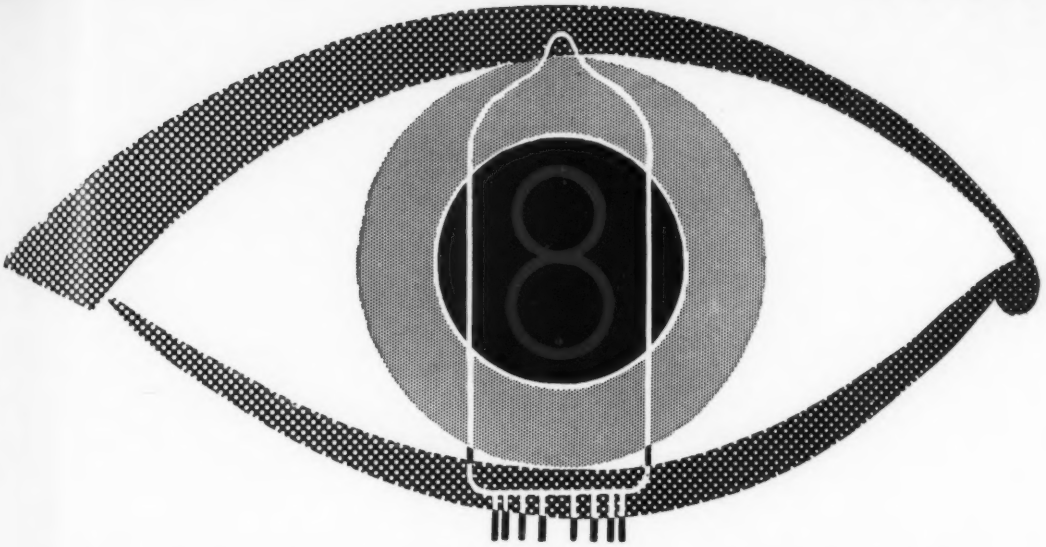
When ordering Compensating Leads from your usual supplier, for greater accuracy specify: "Thermocouple Wires made by A. C. Scott & Co. Ltd., preferred".

A. C. SCOTT & COMPANY LIMITED

TECHNICAL ALLOY MANUFACTURERS FOR OVER THIRTY YEARS

Roundthorn, Wythenshawe, Manchester 23
Tel: WYThenshawe 2231/3 Grams: Cromalay, Manchester

dmA529



INSTANTANEOUS READOUT

with the wide-angle side-viewing

DIGITRON*

The new Ericsson register tube which gives direct numerical display for all digital applications.

The Digitron consists of 10 cathode assemblies arranged to display the numbers 0 to 9 according to the cathode energised.

Number delineation takes full advantage of the essentially rectangular vertical cross-section of the glass envelope and is based on a display area of 30 mm x 17 mm. This represents a considerable increase in both character size and visibility range over end viewing presentation. Further, by adopting such a method of display, an unrestricted view of the numbers is obtained over viewing angles of 60° either side of tube normal without any distortion.

Displayed data can be quickly assimilated without ambiguity by either individuals or groups at distances up to 50 feet over a viewing arc of 120°.

Also available and matching the DIGITRON GR 10 G in size and clarity of readout is the DIGITRON GR 4 G fraction tube which displays "½", "⅓", "¼" & 1.

If you would like more information about the DIGITRON TYPES GR10G and GR4G or have any problems concerning digital display please write to:

THE TECHNICAL SERVICES DEPT.,

ERICSSON

TUBE DIVISION, BEESTON, NOTTINGHAM.

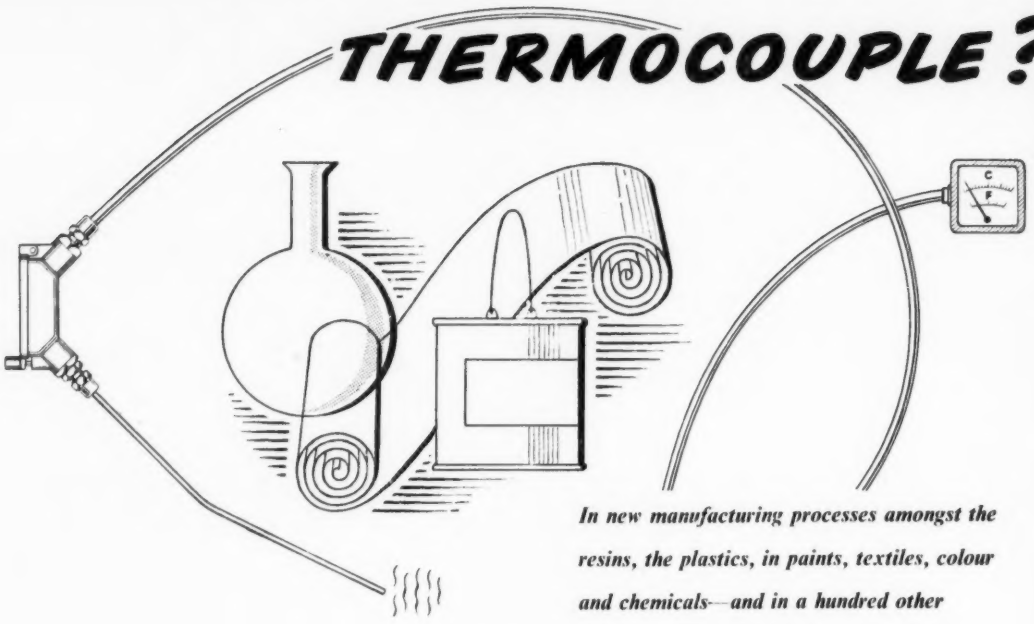
ERICSSON TELEPHONES LIMITED, HEAD OFFICE: 22 LINCOLN'S INN FIELDS, LONDON W.C.2. Tel HOLborn 6936.

* DIGITRON IS AN ERICSSON TRADE MARK

E 89-71AR

Circle 8 for further information

What do you expect of a THERMOCOUPLE?



In new manufacturing processes amongst the resins, the plastics, in paints, textiles, colour and chemicals—and in a hundred other spheres—temperature control is playing a bigger and more vital part.

Higher accuracies, quicker responses, longer life—these are the demands imposed by today's thermo-instrumentation. And, these too, are the inherent features of 'Pyrotenax' Thermocouples. Add to these the characteristics shown and you have the reasons why 'Pyrotenax' Thermocouples are the considered choice of the scientist and technician behind such projects as Bradwell and Calder Hall etc. and other famous enterprises in Industry.

'Pyrotenax' Thermocouples are supplied with conductors of COPPER/CONSTANTAN with either CUPRO-NICKLE or MILD STEEL sheath, conductors of NICKEL-CHROME NICKEL ALUMINIUM ALLOY with NICKEL-CHROME STEEL sheath for high accuracy, high temperature applications.

Full Technical details in Publication 31/U110

✓	**EASILY BENT TO SHAPE**
	they are
✓	**IMMUNE FROM THERMAL SHOCK AND MECHANICAL DAMAGE**
	their
✓	**SMALL OVERALL DIAMETER** permits use in restricted spaces allowing simultaneous readings at different points, where normally only one conventional type could be sited, and generally **NO ADDITIONAL PROTECTIVE SHEATHING REQUIRED**
	resulting in a
✓	**RAPID RESPONSE RATE** comparable with that of mercury-in-glass thermometer
	They have a
✓	**LONG LIFE**
	but, because they are
✓	**INEXPENSIVELY REPLACED** they may be used at temperatures far in excess of those normally permitted for economic operation

Pyrotenax

MINERAL INSULATED THERMOCOUPLES

Use of the name "Pyrotenax" is exclusive to the products of this company and its associates.

PYROTENAX LIMITED HEBBURN-ON-TYNE *Telephone: Hebburn 83-2244/8*

LONDON: *Abbey 1654/5* · **BIRMINGHAM:** *Midland 1265* · **MANCHESTER:** *Blackfriars 6946* · **LEEDS:** *Leeds 27826* · **GLASGOW:** *City 3641/2* · **CARDIFF:** *Cardiff 23619*

GD110

Circle 9 for further information

CIRCUIT MAGNIFICATION METERS

Q INDUCTANCE CAPACITANCE

★ Direct reading of 'Q' Range 10—400
★ Frequency Range 100 kc/s—100 Mc/s
★ Rapid calculation of 'L' and 'Z' by scales incorporated
★ 'Q' Comparison (Model T2 only) Range ± 10%
★ No 'Set Zero' problem

The 'Q' Meters Models T1 and T2 provide a convenient method of making R.F. measurements of circuit magnification, inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. The two models are identical except that the Model T2 provides additional facilities for comparing 'Q', inductance and capacitance, and is most suitable for the production testing of coils.

Model T1 nett price in U.K. **£65**
Model T2 nett price in U.K. **£75**

Full technical details of Model T1 in leaflet No. C31 and of Model T2 in leaflet No. C44.

by

Advance

—to be sure!

STANDARD INDUCTORS TYPE Q101

Consisting of 12 coil units covering inductances from 0.1μH to 30 mH for use with the Advance 'Q' meters. Individually calibrated, these coils are 'standards' for the laboratory.

Set of 12 Inductors in carrying case **£42 0s. 0d.** net price in U.K.
Individual Inductor **£3 2s. 6d.** „ „ „ „

Full technical details in Leaflet No C55

GD72 Advance COMPONENTS LIMITED · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TELEPHONE: HAINAULT 4444

Circle 10 for further information

Sheer precision for Shear Stress

The Ferranti — Shirley Viscometer is capable of giving precise measurement of apparent viscosity over a wide range of shear stress and shear rate.
The accuracy of this instrument is dependent on the low friction properties of the E.P. Specification Hoffmann Angular Contact Bearings and the rigidity which they impart to the cone spindle.

HOFFMANN

BALL AND ROLLER BEARINGS

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

Circle 11 for further information

Products of BRITISH DRIVER-HARRIS

No. 3 Superfine Wires

Manufacturers of precision resistors and potentiometers demand resistance wires so fine that they can hardly be seen. Some ask for wire with a high specific resistance. Others require a comparatively low specific resistance but it must remain constant with changing temperatures. Yet others call for wire with both a high and an unchanging resistance.

Wires are required in various tempers and finishes, for example, hard-drawn, annealed, bright, oxidised, enamelled, enamelled and silk-covered—there's no end to the variations needed for different jobs. Fortunately, there's no end either to our ability to meet them.

Superfine wires are produced from ·002 in. (0·05 mm.) downwards in alloys which are famous, Nichrome*, Nichrome* V, Karma* and Advance*. Alloys which offer all the necessary resistance properties. Finishes which meet all requirements. It's not surprising, perhaps, that our reputation in the superfine wire field is unique.

Nichrome* & Nichrome* V Nichrome* (65/15 type nickel-chromium-iron) and Nichrome* V (80/20 type nickel-chromium) are the alloys most suitable where a high resistance is necessary and where the change in resistance due to temperature does not hinder satisfactory performance.

Karma* This is essentially a modified 80/20 nickel-chromium alloy, developed especially for the electronics industry, which combines a high specific resistance with a low temperature coefficient.

Advance* Wires of this 60/40 copper-nickel alloy have a low temperature coefficient and a fairly high specific resistance—important properties in precision resistors which must have constant resistance over a wide temperature range.

For further information write for Data Sheet No. 1, a 4-page booklet containing comprehensive technical information.

*REGD. TRADE MARK

BRITISH DRIVER-HARRIS CO LTD

NICHROME REGD. TRADE MARK

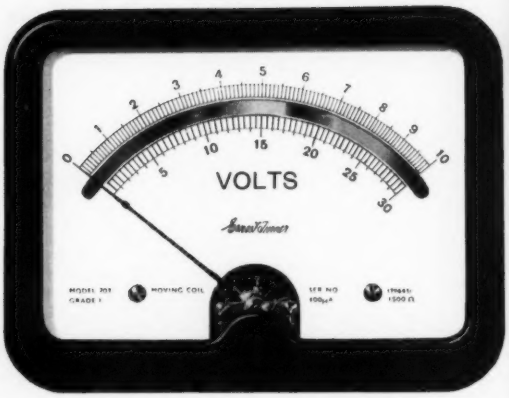
Cheadle Heath, Stockport, Cheshire.

Circle 12 for further information

Precision Electrical Measuring Instruments and Electronic Measuring Equipment

BY Ernest Turner

Ernest Turner precision-built electrical measuring instruments give absolute accuracy, dependability and ease of reading and keeping pace with the ever widening field of electronics, Ernest Turner Electrical Instruments offer a wide range of instruments to meet specific requirements and individual applications. For more than 35 years, in this country and in many parts of the world, wherever there has been a job of precise electrical measurement to be done, the choice has been Ernest Turner instruments



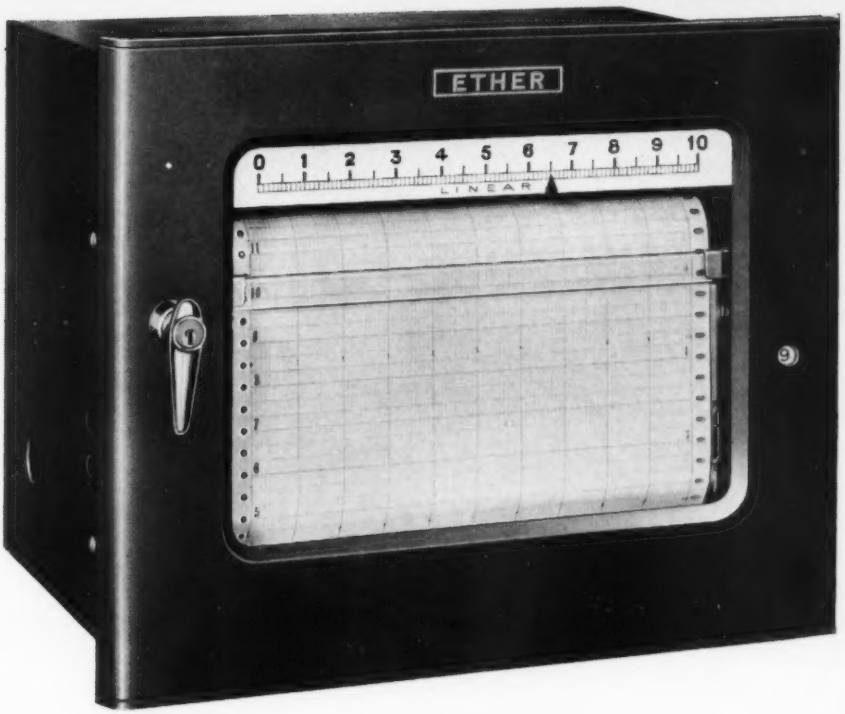
Ernest Turner Electrical Instruments Ltd. HIGH WYCOMBE · BUCKS · ENGLAND

Telephone: High Wycombe 1301-2-3 *Cables: Gorgeous, High Wycombe*

Circle 13 for further information

NEW

high standards of performance at infinitely lower cost!



SERIES 1500

POTENTIOMETER
RECORDERS & CONTROLLERS

* *No standardising required* * *Easy range changes*
* *11-in. calibrated chart with seven speeds*
* *Full-scale balancing pen carriage*
(with speeds of 2, 5 or 13 seconds)
* *Models available to record from one to eighteen independent points*

These new ETHER instruments combine a remarkably high standard of performance with simplicity in operation, and require a minimum amount of maintenance. Models are available which measure, indicate, control and give a permanent record of temperature, using thermo-couples, resistance-bulbs or radiation-tubes. Speed, strain and any other variable that can be resolved into an electrical signal can also be recorded. Write now for comprehensive technical data!

ENQUIRIES, SALES & SERVICE:
Tyburn Road, Erdington, Birmingham, 24 East 0276-8
Caxton Way, Stevenage, Herts. Stevenage 2110-7
Representatives throughout the U.K.
Agents in all principal countries

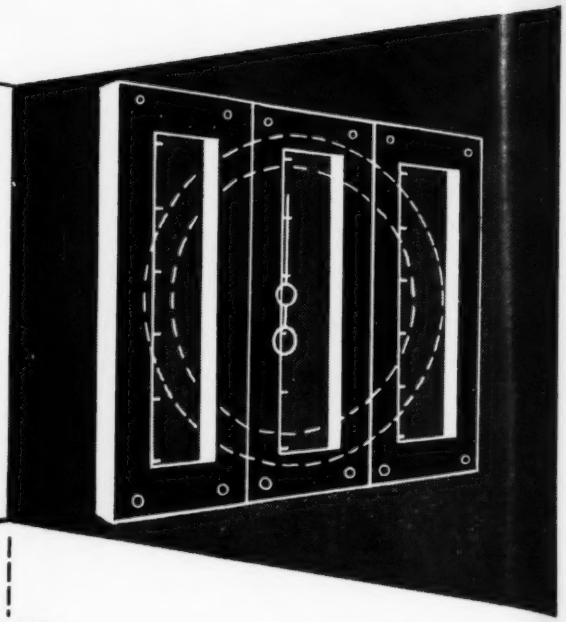
ETHER LIMITED

TEMPERATURE & PROCESS CONTROL EQUIPMENT FOR ALL INDUSTRIES

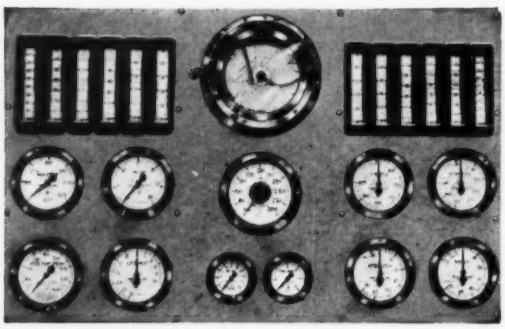
Circle 14 for further information

Save Panel Space

FIT SYDNEY SMITH FLAT-FACE EDGEWISE PRESSURE GAUGES

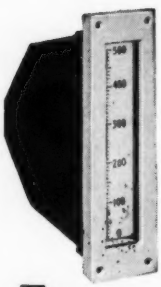


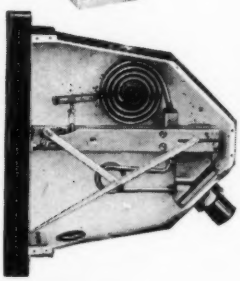
"GRASSHOPPER" PATENT
Size 8" in accordance with B.S.S. 1780-1951.



The TWELVE Edgewise Gauges in the panel above occupy approximately **HALF THE SPACE** *of the ELEVEN conventional dial type.*

Being Flat-Faced there is no Glint





SYDNEY SMITH & SONS

(NOTTINGHAM) LTD., · BASFORD WORKS, · NOTTINGHAM
TELEPHONE: 75031/3 *GRAMS: "SMITH'S, NOTTINGHAM."*

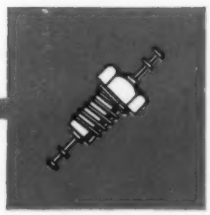
THE OLDEST PRESSURE GAUGE MAKERS IN THE WORLD

London Office: WHITT & CHAMBERS Ltd. 6 Lygon Place S.W.1
PHONE: SLOANE 7294/5 *GRAMS: WHITCHAM SOWEST, LONDON*

Circle 15 for further information

precision built

W. 7021 FEED-THROUGHS



A ROBUST COMPONENT
of medium size, the Alkyd insulation is moulded around a solid turned conductor to carry 5 amps, and forms a U.N.C. threaded body.

HARWIN ENGINEERS LTD

RODNEY ROAD · PORTSMOUTH · HAMPSHIRE Tel. Portsmouth 35555 (4 lines).

Circle 16 for further information

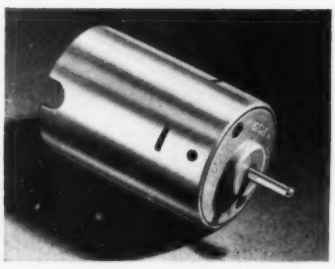
PULLIN

D.C. INSTRUMENT MOTORS

Interservice Standard P.M. Motors

Low voltage, high efficiency, permanent magnet d.c. motors in International Standard Size housings sizes 08 to 18 and designed to operate under the most severe conditions. (Right) The small 08 P.M. 1.75 inches long, 0.75 inches diameter. Giving up to 4 watts mechanical power output. Withstands the Climatic Test Conditions of M.O.S. Spec. DTD. 1085B and Interservice Spec. K114/B and K114/J. For 6, 12 or 28v. D.C. operation and is available as a Rate Feedback Tachogenerator.

Type	Torque grm/cm.	Speed r.p.m.
18PM	300	5000
15PM	240	5000
11PM	120	5000
08PM	65	5000



General Drive Motors

Motor Type Series P.M.1.

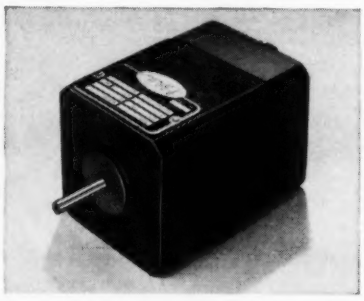
A miniature permanent magnet motor giving approximately 80 grm/cm at 5000 r.p.m.

Length: 2 inches, Diameter: 1.3 inches, Weight: 4.5 ozs. In a range of voltages and shaft variations.

Square Bodied Motors

Shunt Wound Field

Type	Torque grm/cm.	Speed r.p.m.
B12	340	3500
B8	275	3500
D6	80	4100



Governed Motors

Totally enclosed centrifugal type governor ensures close and accurate speed control.

Type	Torque grm/cm.	Speed r.p.m.	Control
18PM(G)	250	3000	±1%
15PM(G)	40	3000	±¼%
11PM(G)	120	3000	±1%
PM1CX	80	2000-4000	±3%

R. B. PULLIN'S long precision instrument engineering experience together with the development of new manufacturing processes and techniques is evident in the specification and high performance of Pullin and Pullin — Kearfott components. A comprehensive range of motors and servo-components is listed in our catalogue which will be gladly sent on request.

THE PULLIN GROUP
R. B. PULLIN & CO. LTD.
Measuring Instruments (Pullin) Ltd.
Aldis Brothers Ltd.
Pullin Optical Co. Ltd.
Stanley Cox Ltd.
Donvin Instruments Ltd.

A.C.
SERVOCOMPONENTS

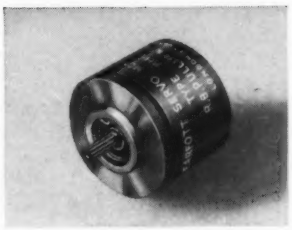
PULLIN

Pullin-Kearfott Motor Generators

(Left) The Pullin-Kearfott Size 10 Motor-Damping Generator Type R807 for damping applications where high accuracy, small size and low inertia are required. The low in-phase null makes the R807 ideal for simple rate servos. See also R800, R801 and R806, high performance Motor-Damping and Motor Rate Generators.

Size	Type	Stall Torque grm/cm	Output volts at 1000 r.p.m.	400 c/s
10	R807C	25	0.4	26 v. Operation.
10	R807GC	35	0.5	20 v. Centre Tapped. Mk. 18 Mod. 2
15	R800	105	3	Mk. 12. Mod. 0.
15	R800G	105	3	20 v. Centre Tapped.
18	R801	172	3	Mk. 16. Mod. 0.
18	R806	205	3	High Power.

Pullin-Kearfott Servo Motors



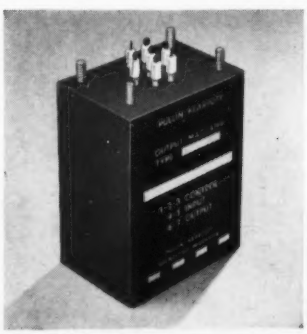
Size	Type
10	RH 118B High Temperature
10	R 124G 20 v. Centre Tapped
10	R 124S 40 v. Centre Tapped

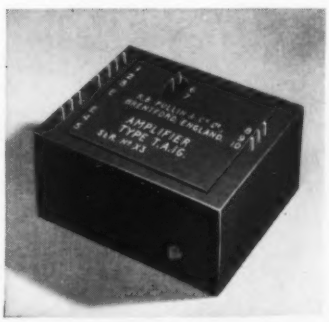
Pullin-Kearfott Synchros

High precision units to N.A.T.O. and Bu-Ord standards. Sizes 11 and 18, 400 c/s 115v and 26v operation. Range includes a 7 terminal Size 11 Control Resolver R982-21B—BuOrd 11R13N4.

Magnetic Output Amplifier

Types R601/604 to provide control phase power for the complete range of Pullin-Kearfott servomotors and motor generators.





Transistor Amplifier T.A.I.G

A miniature resin-moulded germanium transistor amplifier for use with size 10, 11 and 15 servomotors.

R. B. Pullin (parent company of the Pullin Group) with a world-wide reputation for high performance precision instruments and equipment, and the combined resources of the Pullin Group, offer design and development service in all branches of instrument engineering.

ENGINEERS: We are always pleased to hear from qualified engineers seeking interesting and progressive development work in a live and expanding company.

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"THE SEAL-IN-A-SECOND"

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---with the 'feather touch' control

★ THE HIGH SPEED PRESS - BUTTON GUMSTRIP (REGD.) SEALING TAPE SHOOTER

- SAVES FATIGUE IN PACKING
- SAVES TAPE BY PRE-SET LENGTHS
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- MORE PARCELS PACKED PER DAY
- DESIGNED FOR RAPID SEALING OF HEAVY BALES, CARTONS AND CONTAINERS
- Send for the illustrated leaflet or ask for a free demonstration in your packing department.

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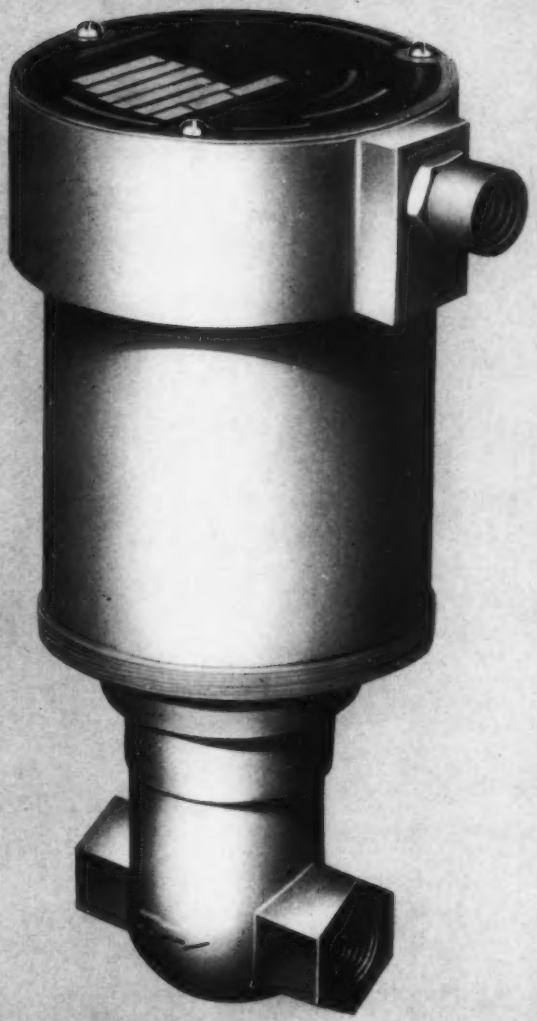
Completely New Range!

ETHER LIMITED

SOLENOID VALVES

— illustrated is one of the HP series high-performance valves for high-viscosity oils



One of an outstanding new range of solenoid valves recently introduced by ETHER LTD., the HP valve is particularly useful for oils of high or low-viscosity. Available in three ranges, each with a different electro-magnetic assembly, ETHER HP valves are also suitable for low and medium-pressure applications with water, air and many other media.

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Solenoid Valve Division

TEMPERATURE & PROCESS CONTROL EQUIPMENT FOR ALL INDUSTRIES

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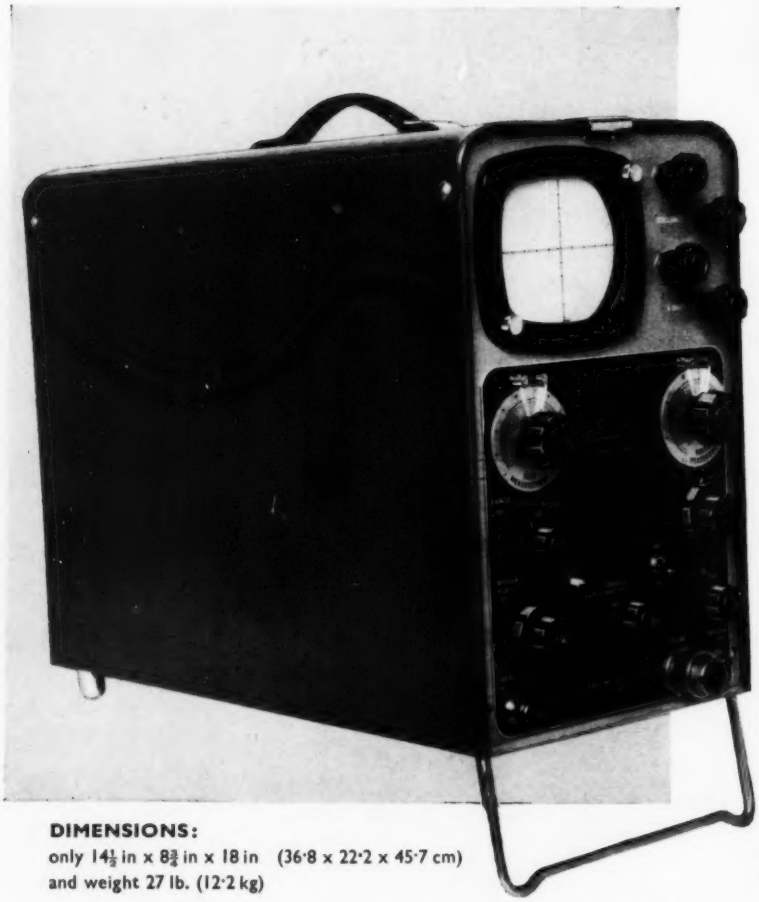
The Oscilloscope with 220 Mc/s bandwidth



TYPE L362

- Rise time 2 milli-microseconds
- Sensitivity 150 mV/cm
- Can handle repetitive pulses of random separation
- Extremely compact and portable
- Inexpensive

DIMENSIONS:
only 14½ in x 8¾ in x 18 in (36·8 x 22·2 x 45·7 cm)
and weight 27 lb. (12·2 kg)

Working on a novel sampling principle, the L362 provides nucleonic and electronic engineers with an inexpensive oscilloscope capable of recording rapid pulses at the higher frequencies.

The L362 oscilloscope has been developed from a design originated by the United Kingdom Atomic Energy Authority Research Establishment, Harwell.

A PRODUCT OF
MULLARD EQUIPMENT LIMITED
A COMPANY OF THE MULLARD GROUP

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INSTRUMENT HOUSE
207 KING'S CROSS ROAD · LONDON W.C.1

Overseas
MULLARD EQUIPMENT LIMITED
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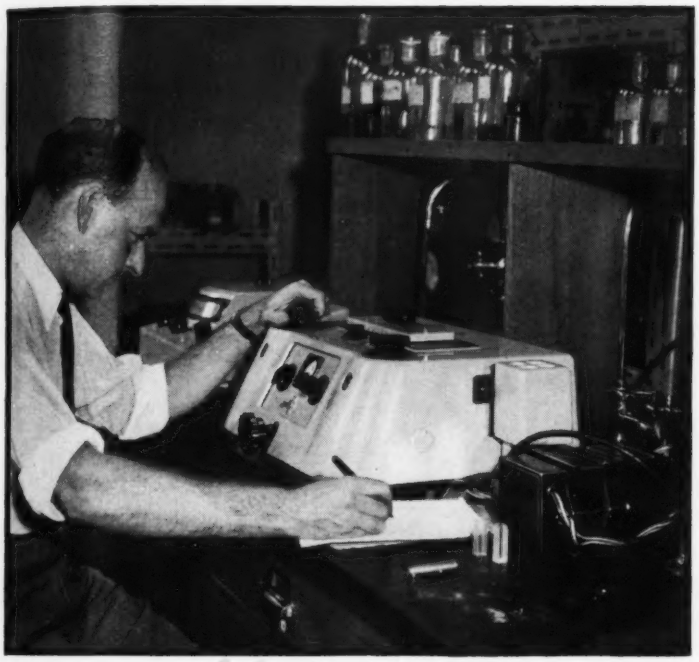
TORRINGTON PLACE · LONDON W.C.1

Circle 20 for further information

A Mains Voltage Fluctuation problem



A Unicam type SP 600 Spectrophotometer in use with an 'Advance' C.V.T.

in Absorption Analysis

The Spectrophotometer employs a particular optical/electronic system in which a light source, photocells and special amplifier play a vital part. Vital, because it is upon their correct performance characteristics that the accuracy of the instrument depends.

But their correct performance, in turn depends upon a stable supply voltage. How is this achieved?

. . . straightened out by

In the Unicam S.P.600 Spectrophotometer illustrated, the tungsten lamp and valve heaters in the amplifier are supplied from the mains through an 'Advance' Constant Voltage Transformer (seen on the right of photograph). As a result the accuracy of the instrument is unaffected by fluctuating supply voltage.

'Advance' Constant Voltage Transformers provide a.c. voltage stabilization of ± 1% for input variations of up to ± 15% at maximum load. For power requirements from 4 to 6,000 watts, they are automatic and contain no moving parts.

Advance

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"VOLTAGE STABILIZATION"

This 'Advance' Booklet gives authoritative information on 'Advance' Constant Voltage Transformers, and the service available to deal with your particular voltage fluctuation problems. Send for a copy.

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Circle 21 for further information

The magnetic A.C. voltage regulators

with all the trumps—

SORENSEN

of course!

Ⓐ Accuracy ± 0·5%

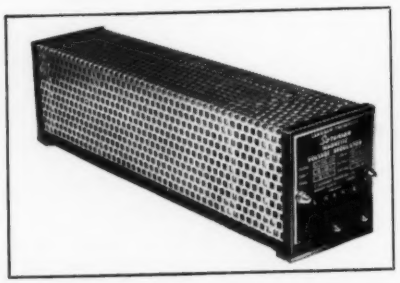
Ⓚ Fast response time

Ⓠ Low cost

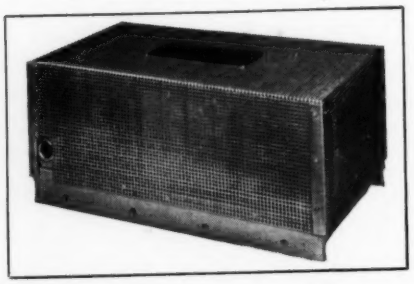
Ⓙ Small and compact

⑩ Easily incorporated into standard equipment

Model LT-MVR-120/BM



Model LT-MVR-1000/BM



Input Voltage range 190v — 260v, 50 c/s. Output Voltage (nominal) 228v—232v. Time Constant 20-80 milliseconds. Bench and wall mounting forms are standard, but sub-unit or rack mounting models are also available.

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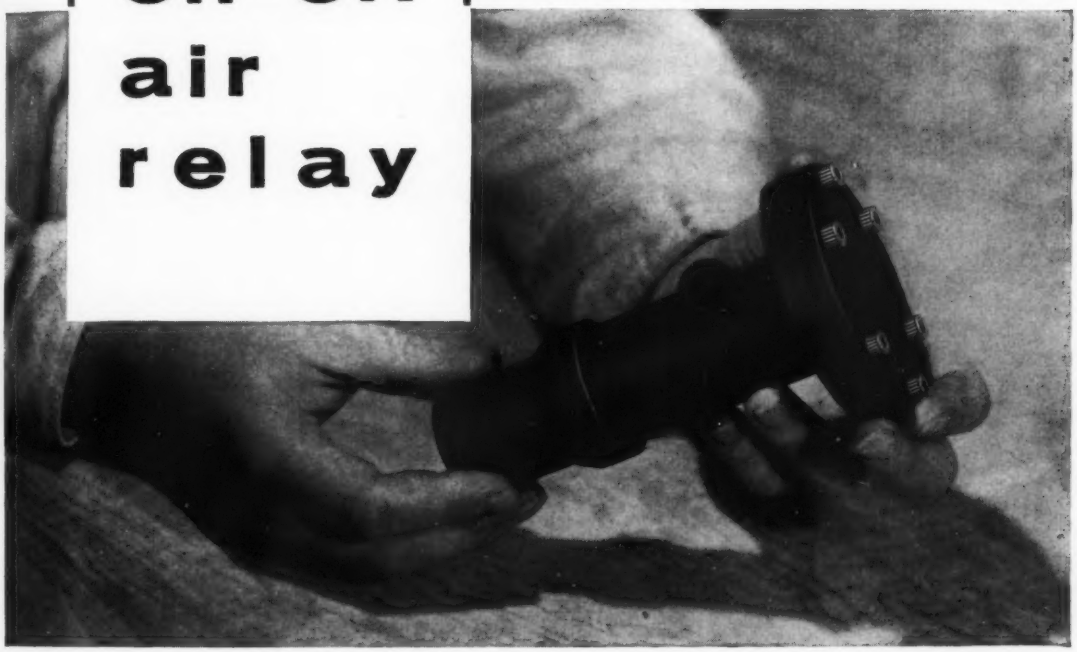
Circle 22 for further information

on-off air relay



This device opens or closes one air circuit when the pressure of another air supply (connected to the relay diaphragm) varies above or below a predetermined value. Designed primarily for use as an air lock on Hammel-Dahl Diaphragm Control Valves, it is now finding many other applications, where conditions call for sturdy reliability rather than the high sensitivity of the more delicate "instrument" type relay. Examples of its use include the actuation of sequencing devices, operation of safety alarms, and the isolating of units of pneumatic equipment in emergency.

It is of rugged construction; weather-proof; of high capacity; gives positive tight shut-off; and is adjustable in service.

OPERATING DATA	
SET POINT	Adjustable from 3 to 20 psig.
MAX. PRESSURE ON DIAPHRAGM	200 psig.
MAX. SUPPLY PRESSURE	100 psig.
THROTTLING RANGE (Change in pressure on diaphragm to move from closed to full open position).	3 psi. (with downstream pressure constant).

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3-WAY & 4-WAY SOLENOID OPERATED VALVES

. . . . . DESIGNED FOR USE WITH AIR CYLINDERS

MIDGET 3-WAY SOLENOID VALVE, TYPE AC30.

For use on air up to 150 p.s.i. and port sizes to $\frac{1}{8}$ in. diameter screwed $\frac{1}{4}$ in. B.S.P. used for controlling air-operated cylinders and diaphragms with spring return.

★ *Write for illustrated literature*

MIDGET 4-WAY SOLENOID VALVE TYPE AC40.

For use on air up to 150 p.s.i. Port sizes up to $\frac{1}{8}$ in. screwed $\frac{1}{4}$ in. B.S.P. used to control double acting air-operated cylinders and diaphragms.

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- HARDENED TEMPLATES NOT ESSENTIAL
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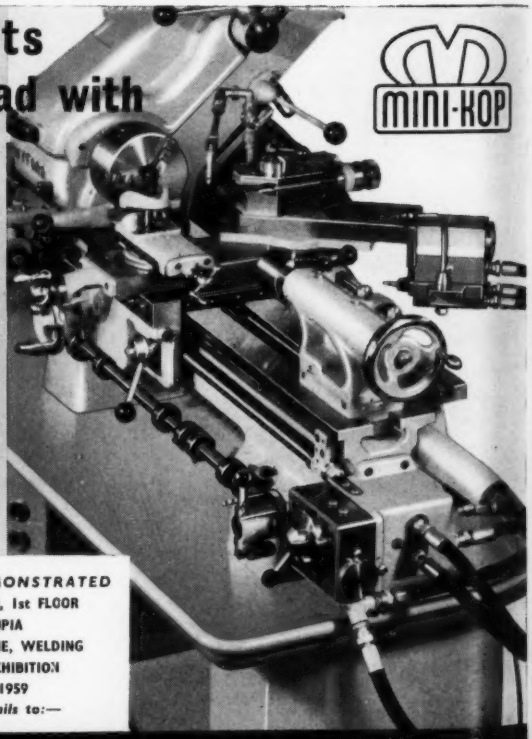
MYFORD MACHINE TOOLS



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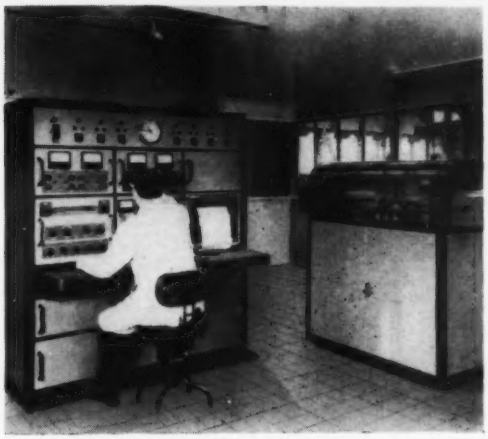
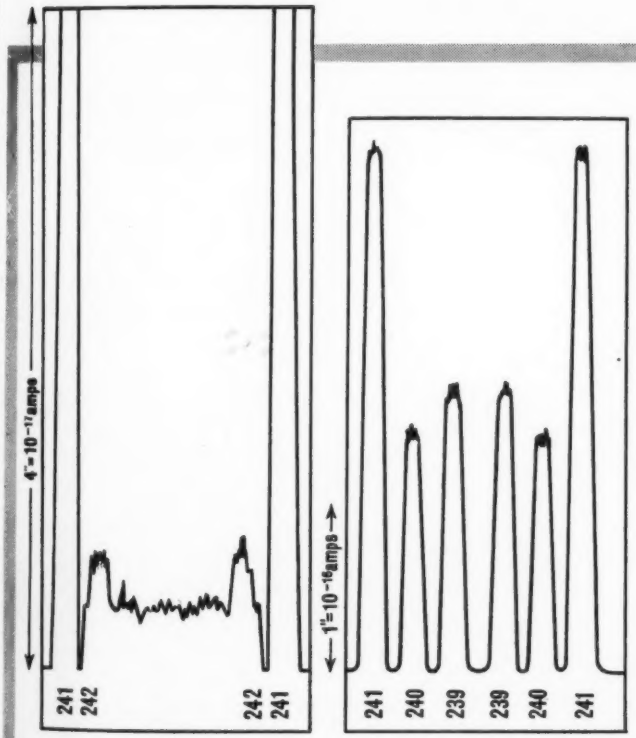
The Metropolitan-Vickers Range of Scientific Equipments includes apparatus for the investigation of metallurgical, chemical and biological problems in research, production or processing. These equipments cover a wide selection of specialised scientific apparatus.



MASS SPECTROMETER TYPE MS5 *An instrument specially designed for the measurement of isotope ratios of inorganic solids by the surface ionisation technique.*



ANALYSIS OF PLUTONIUM

$\frac{m}{e}$	239	240	241	242
% ABUNDANCE	27·20	23·10	49·60	0·072
STANDARD DEVIATION	0·25	0·30	—	0·007

Tabulated results and traces from sample of approximately 10^{-8} grams of plutonium nitrate, using the triple filament technique and the multiplier detector. The standard deviation quoted is taken on 10 measurements.

These results are reproduced by kind permission of the United Kingdom Atomic Energy Authority Atomic Research Establishment, HARWELL, Didcot, Berks.

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For assembling pipe line systems quickly and easily, use standardised Simplifix couplings. Made to B.S.S. 2051 Part I, their high standard of dimensional accuracy ensures that all fittings are interchangeable. They can be used on almost any kind of tubing, including those with very thin walls, and are available in the widest possible variations of standard and non-standard fittings. In brief you are most likely to find *your* requirements in the Simplifix range. Our illustrated catalogue gladly sent on request.

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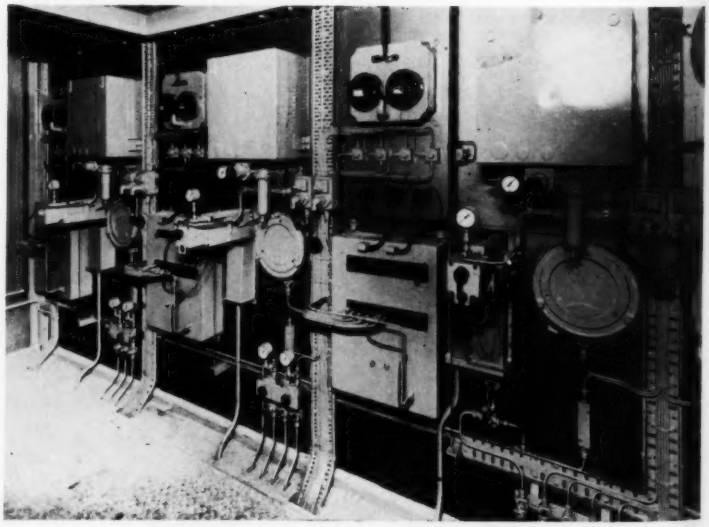
IT WILL PAY YOU.



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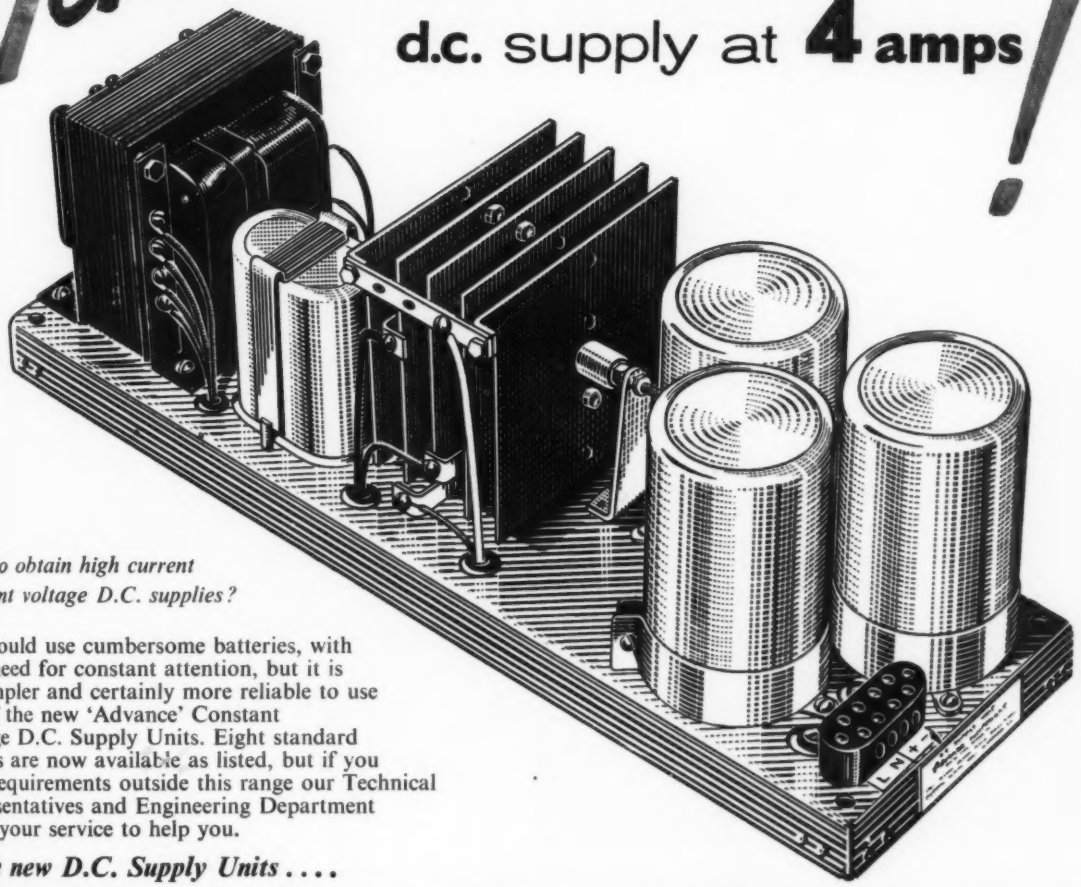
Circle 28 for further information

Here is a 12v. stabilized d.c. supply at 4 amps!



How to obtain high current constant voltage D.C. supplies?

You could use cumbersome batteries, with their need for constant attention, but it is far simpler and certainly more reliable to use one of the new 'Advance' Constant Voltage D.C. Supply Units. Eight standard models are now available as listed, but if you have requirements outside this range our Technical Representatives and Engineering Department are at your service to help you.

These new D.C. Supply Units . . . .

- Provide **HIGH CURRENT OUTPUT AT LOW COST**
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DC/6/4	6 volts	4.00 amps	£25
DC/12/1.25	12 volts	1.25 amp	£20
DC/12/4	12 volts	4.00 amps	£30
DC/24/1	24 volts	1.00 amp	£25
DC/24/5	24 volts	5.00 amps	£45
DC/48/1	48 volts	1.00 amp	£35
DC/48/4	48 volts	4.00 amps	£60

Advance CONSTANT VOLTAGE

D.C. POWER SUPPLIES

Full technical details available in Leaflet C59.

GD 77

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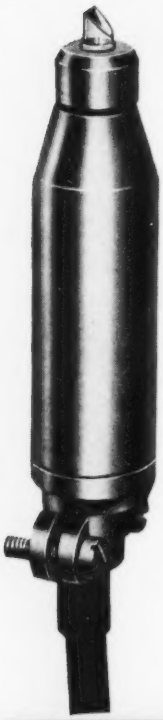
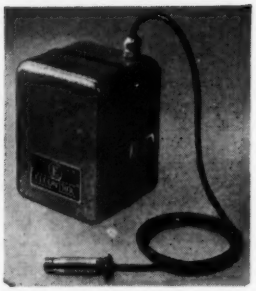
photoelectric controls



in miniature!

This picture of the new Elcontrol Viewing Head is life size - so you see it *is* a pretty small Viewing Head, thanks to the very small photocell tucked away inside it.
Small itself, it also responds to very small observed objects.
Photoelectric controllers are ideal for most control jobs where movement has to be detected - tell us what you want to do and we will gladly help you.

ELCONTROL



This is the new photorelay —also a small, compact unit in a variety of types for different applications

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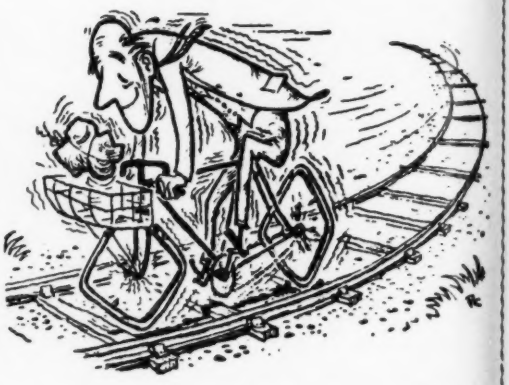

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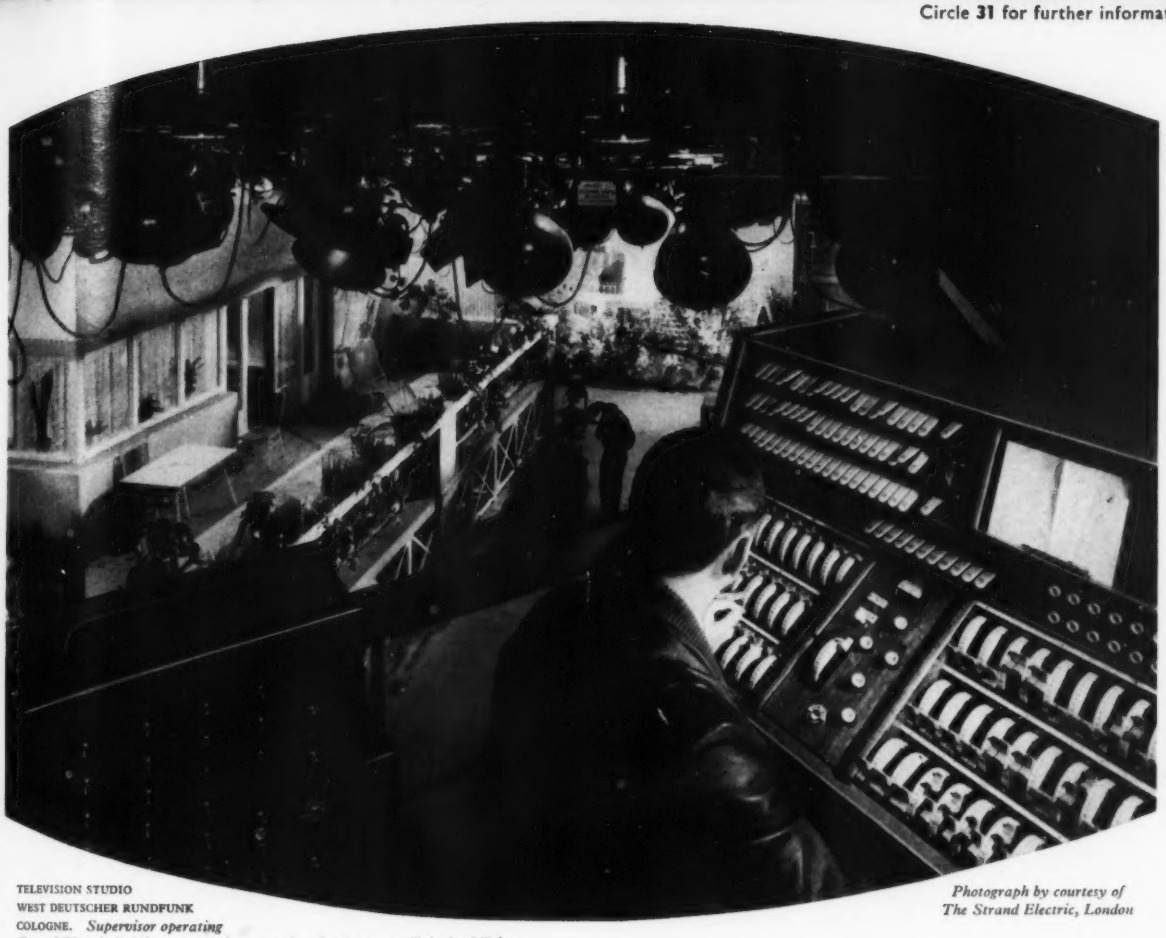

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COLOGNE. *Supervisor operating*
Strand Electric lighting control incorporating the Carpenter Polarized Relay.

Photograph by courtesy of The Strand Electric, London

COLOGNE TOO looks to the Carpenter Polarized Relay

Television viewers are fascinated by the endless variety of information and entertainment efficiently presented.

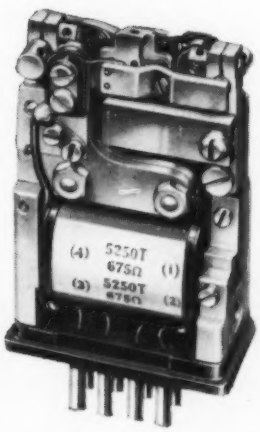
Behind the scenes some of the wonders are worked by push-button operated devices incorporating the Carpenter Polarized Relay.

One such device is the Strand Electric Console-Preset Light Control. Its dimmer servo system depends on the sensitivity and reliability of the Carpenter Polarized Relay to meet every demand with unrelenting efficiency.

Carpenter Polarized Relays are used throughout the world for Control, Amplification, Impulse Repetition, Switching etc., etc.

If you have a problem please consult us. Our team of engineers will be happy to discuss it with you.

Please write or telephone for details and technical data.



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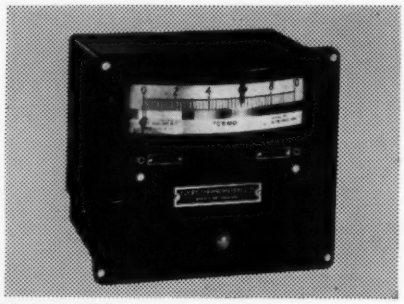
Will control with a differential of ·25 of 1% over all thermo couple ranges to 1600°C or 3000°F. Control is adjustable over the full range. Scale 4". Panel Cut out 5¼" x 5¼". Rating 5 amps @ 230V. Ask for Brochure Z5.



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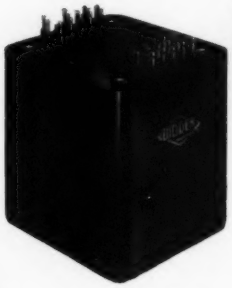

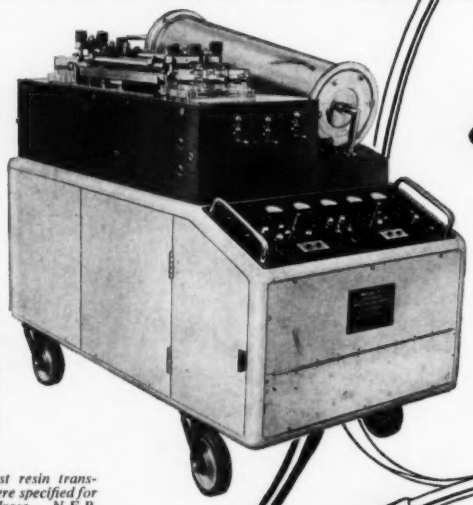

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You will find Woden Transformers specified for reliability on precision instruments of every type.
Rigid construction and careful assembly combine to guarantee absolute reliability throughout many years of service.
Catalogues available on all types of transformers.

Woden cast resin transformers were specified for the Melrose N.E.P. Heart and Lung Machine

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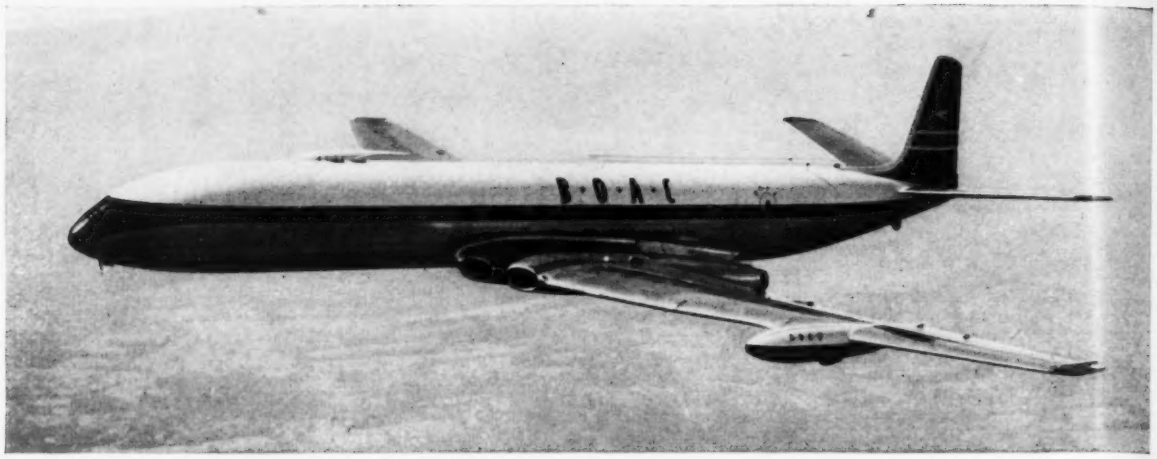

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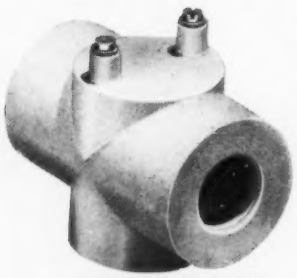
The Type RC4 conductivity controller continuously monitors the purity of processed waters, wash and rinse waters, steam condensate, effluent concentration, etc., and operates electrical ancillaries such as magnetic valves, visual or audible signals, when the conductivity reaches a predetermined value.

A wide selection of indestructible measuring cells for a variety of conditions are available for use with the control.



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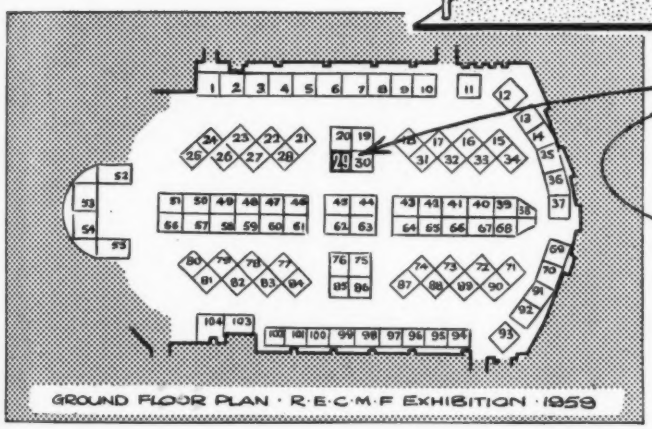

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MEASURES OHMS : 50Ω to 5MΩ

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MEASURES D.C. : 10 mV to 1000 V

MEASURES OHMS : 0.02 Ω to 500 MΩ

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TC 146

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by sefram of paris

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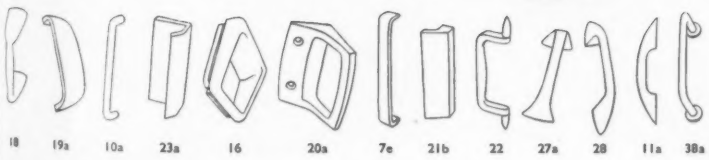

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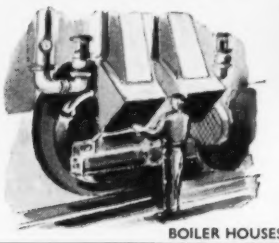

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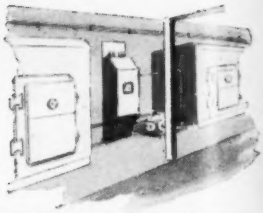

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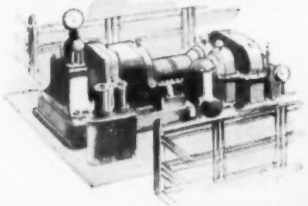

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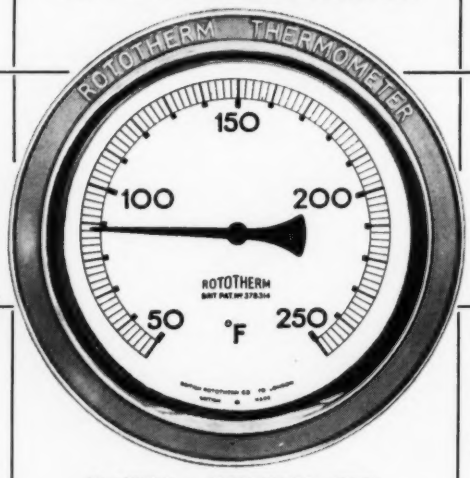
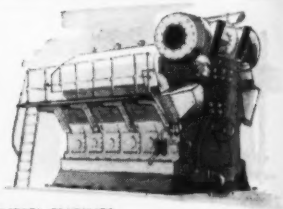
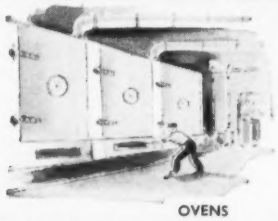
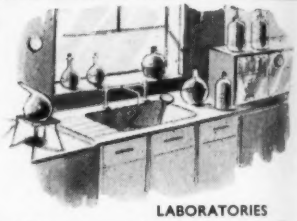




DIESEL ENGINES



OVENS



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D.C. Volt readings from 10mV—2,500V (25kV by probe)
(0.5, 2.5, 10, 25, 100, 250, 1,000, 2,500)
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(10, 25, 100, 250, 1,000, 2,500)
Ohms from 0—200 megohms in 4 ranges (self-contained).
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Accuracy 2% D.C. 3% A.C. 5% Ohms.
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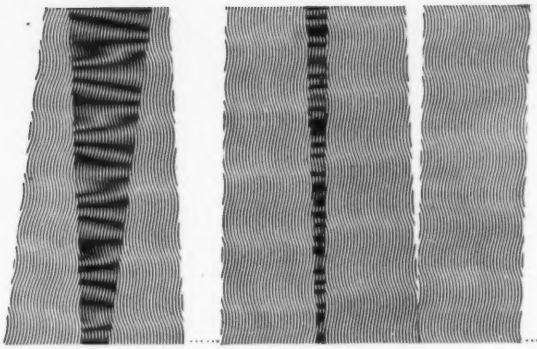
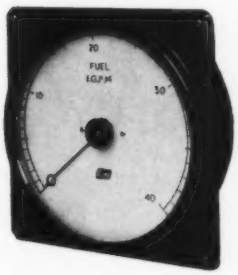
WHAT'S THE FLOW UP TO?



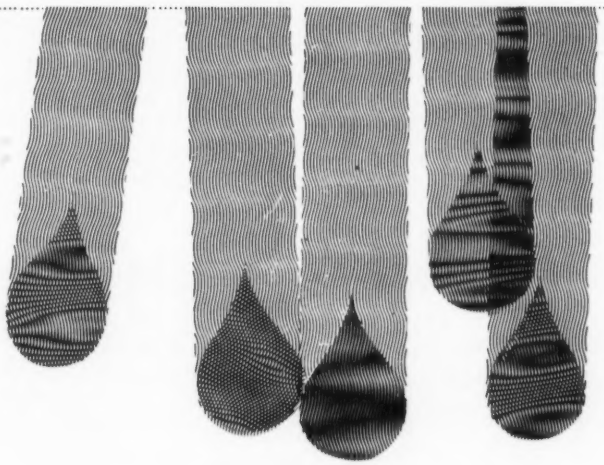
Components of a typical installation

Flow Transmitter

Electronic Integrator



Flow Rate Indicator



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VARIACS can be supplied open or covered, as single units or ganged assemblies of two or more units, for manual operation or motor-driven. The range includes portable models, metalclad models, dual-output models, high-frequency types, and many 'specials'.

*DURATRAK is a rhodium-covered, silver-plated track surface, which inhibits oxidation of the brush track and greatly reduces contact resistance, giving longer life, increased overload and surge capacity and maximum economy in maintenance.

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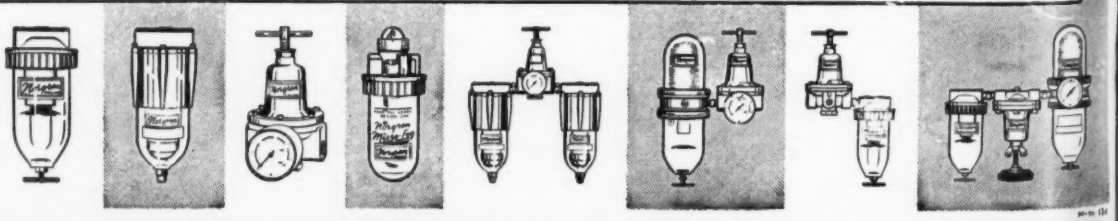

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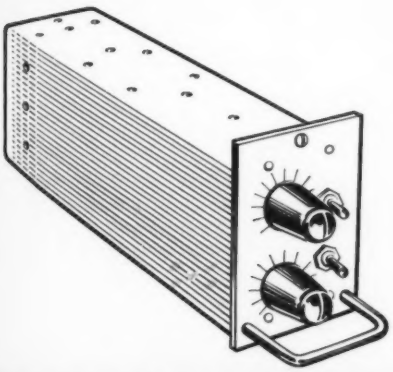
Circle 46 for further information

A.W.A

ELECTRONICS

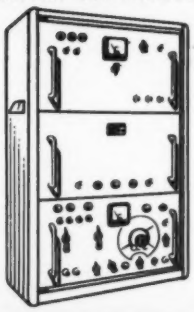
New concepts in electronics have been developed at AWA, as a result of experience with missile systems. Now they have a wider application. Here are some of the new AWA devices now available to industry.

TRANSISTOR GALVANOMETER AMPLIFIER



This Amplifier has been designed to drive viscous damped recording galvanometers which normally have a resistance of 50 ohms and a working range of D.C. to 2 Kc/s in frequency. The amplifier has a switched attenuator at its input and will accept single ended or push pull signals from ± 1 Millivolt to ±500 volts and will feed a maximum of ±50 Milliamps to the galvanometer. There is also a range of ancillary units available for use with this Amplifier as part of a comprehensive instrumentation system. *Standard specification: Dimensions: 4¼ in. x 3¾ in. x 10 in.; Frequency response: Flat from DC to 2 Kc/s, 5% down at 3 Kc/s, 3db down at 6 Kc/s; Noise level: less than 10 Microvolts; Input impedance: 40,000 ohms on range 5, 110,000 ohms all other ranges; Gain: Maximum 7.5 Milliamps/Millivolt, minimum 0.04 Milliamps/Volt; Power requirements: ± 6 Volts D.C. 220 Milliamps each line.*

COMEL 8 & 12 SWEEP OSCILLATOR AND VIBRATION CONTROLLER



This unit is designed to drive vibrator amplifiers and has a wide frequency range. The sweep speed is variable over a range 12:1 and automatic frequency sweep facilities are provided. *Frequency Range: 10 c.p.s. to 32 Kc/s in ranges of 5 octaves each. There are 7 switch speeds ranging from 5 secs./octave-60 secs/octave. Variety of Outputs available. Vibration Controller: Input: 4V r.m.s. at appropriate frequency. Output: Up to 100 mV r.m.s. into 600 ohms. Pick Off: Sensitivity 10 mV r.m.s. per "g" peak. Overall Dimensions: 35" x 22" x 14". The Vibration Controller will control ± 40 "g" or as determined at low frequencies by the excursion of the vibrator table.*

All devices are adaptable to suit customers' own requirements. For further information consult:

COMMERCIAL ELECTRONICS DEPT.

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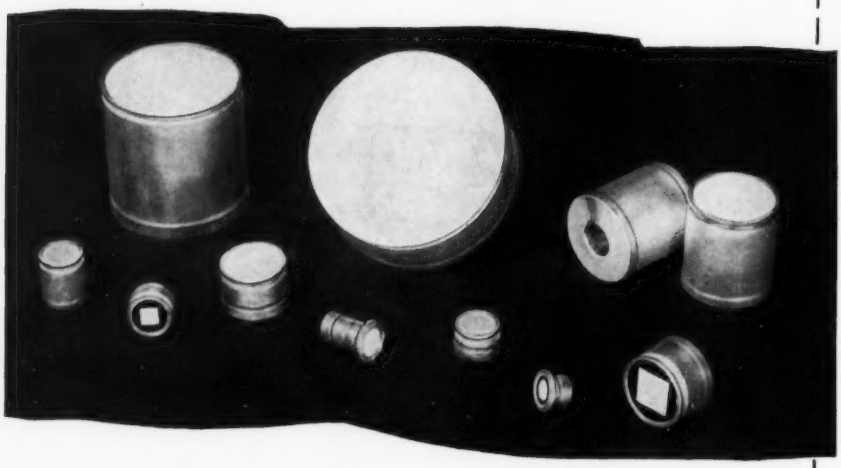

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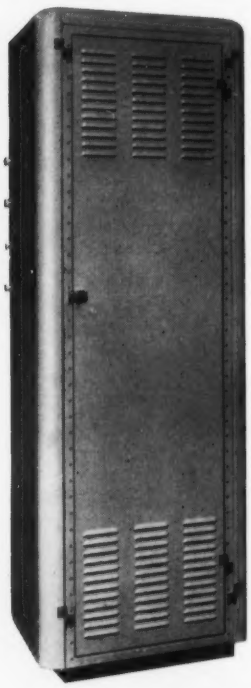

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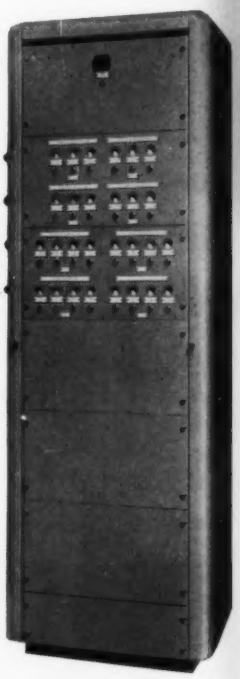

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Circle 49 for further information

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for temperature control problems

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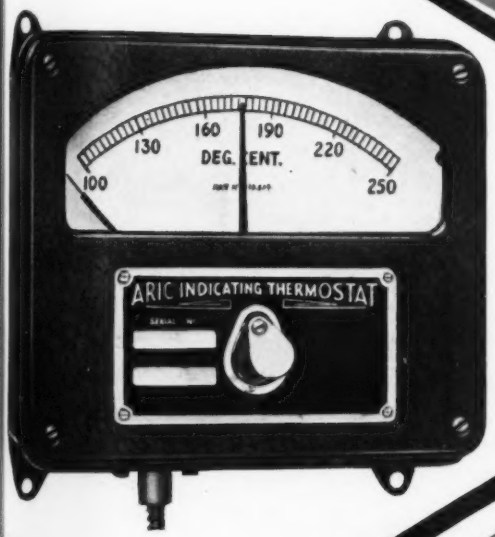

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INSTRUMENT Practice
AUTOMATION & ELECTRONICS

Editor: J. T. Miller, B.Sc., F.Inst.P.

VOL. 13. No. 4

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COMMENTARY

I.E.A. Large-scale preparations are already in hand for the 1960 Instruments, Electronics and Automation Exhibition. It will be remembered that a decision was taken at the end of the 1957 Exhibition to make the show an international one, I.E.A. 1958 contained a nucleus of overseas firms, but not really enough to justify the use of the term "international" as applied to the exhibition. To rectify this a three-man team has just visited Denmark, Germany, Italy, France and other European countries. The team was composed of Mr. C. Hanrott, chairman of the I.E.A. promotion committee, Mr. E. D. Hart and Mr. E. Rees, both directors of International Exhibitions Ltd. A display unit and a wealth of publicity material were taken and conferences were held at principal towns such as Copenhagen, Dusseldorf, Frankfurt, Munich, Milan and Paris. With rising unemployment in this country, it may seem a paradox to invite competitors to display products at a British exhibition. The opinion, however, of the majority of British instrument manufacturers is contained in Mr. Hanrott's statement just prior to the tour.

"The I.E.A. Exhibition is already international—that is, it is open on equal terms to any instrument or electronics manufacturer from any part of the world who wants to show his goods in London, and show them on equal terms with our own British suppliers. We believe this is a good and healthy thing—indeed, we welcome the opportunity of exhibiting our own products alongside them, so that the buyers of the world can see them side by side and judge for themselves just how good British equipment really is.

"In its short two years of public life, the I.E.A. Exhibition has already, I believe, achieved a very great thing. It has played a major part in helping to establish Britain—and in particular, London—as the instrument and electronic centre of the Continent of Europe, and probably of the world. The reputation of this country in such fields has grown enormously since it has become the location of a great international exhibition . . . the forum of the very successful conferences which have been staged with it . . . and since thousands of overseas buyers have come to study our techniques, meet our designers and manufacturers, and join in discussions with our own people."

Sir David Eccles, in a message, said:

"The exchange of ideas at which your exhibitions aim, is therefore of the highest value and importance. Please tell our European friends that we shall welcome them, that we shall hope to learn something from them, and that we believe they will have something of value to learn from us."

In view of the European Customs Union and the projected Free Trade Area (which in spite of many set-backs it is hoped will be concluded before long), the next I.E.A. Exhibition will possess a significance not accorded to its predecessors, and the results of the tour will be of great interest to instrument manufacturers.

British Instruments Directory The British Instruments Directory is now being distributed, and to a wide circle abroad. There are many fine directories and buyers' guides issued by continental countries, notably France and Germany, giving considerable prestige to the industries they represent. It is felt that the British Instruments Directory is, at the least, equal to the best of these and will exert corresponding influence on behalf of the instrument industry at large.

Research and Technical Institutions The small number of post-graduate research students in technical institutions was deplored by Sir Harry Melville, K.C.B., F.R.S., Secretary of the Department of Scientific and Industrial Research, during the course of his address at the Annual General Meeting of the Association of Technical Institutions on 27th February, 1959. He mentioned various methods by which the number might be increased.

There is no doubt that a large percentage of instrument personnel will have to come from technical colleges in the future, and any plan which makes such colleges attractive to students proceeding to higher degrees will be welcomed.

The attraction of universities for research purposes is recognised and it is not argued that the greater proportion of post-graduate students will study there in the future. One of the contributory difficulties relating to technical colleges may be the lack of a recognised qualification and the recently created "Membership of the College of Technologists" is an effort to correct this omission. To assist matters, the D.S.I.R. have agreed to accept alternative qualifications to an honours degree including the new Diploma in Technology for the award of studentships. It does not seem impossible for doctorate degrees to be awarded by the larger technical colleges. The teachers could be "recognised" or "appointed" in a similar fashion to other institutions.

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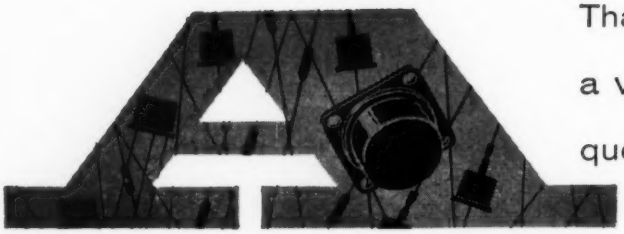

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T 34

CALIBRATION OF ACCELEROMETERS

By J. R. H. LEWIS, A.Inst.P.

Admiralty Engineering Laboratory

Introduction

THE isolation of machinery vibration from its surrounding supports and attachments is a problem which today concerns many branches of technical science. This, in general, is due to the increasing complexity of new equipment; the development of engines having a greater power/weight ratio, and a general awareness of the detrimental effects of sustained and transient oscillating forces on machinery of all kinds and, of course, on personnel. In many cases only low frequencies need be considered, but in the Navy a special problem exists in the prevention of machinery generated vibration over a wide band of frequencies from reaching the hull and substructure of a surface ship or submarine. This is usually effected by the introduction of resilient mountings between the machine and its seating. In order to determine the effectiveness of such palliative measures the extent and character of the vibration spectra must be measured as accurately as possible. To do this vibration pick-ups are employed in the form of electro-mechanical transducers and for one reason or another it is generally found that piezoelectric crystals are the most suitable for the purpose.

The X-cut quartz crystal has been extensively used for many years, but more recently highly stable electrically polarised barium titanate ceramic materials have come into favour. This is due mainly to their small size, high sensitivity and low cost. When used as a voltage generator barium titanate crystals have an internal electrical impedance amounting to several hundred megohms, and generally require the use of a head amplifier in the form of a cathode follower. This permits transmission of the pick-up signal over lines of up to five hundred feet in length with negligible loss. The signal can then be fed through an amplifier into some suitable analysing device such as a third octave filter or discrete analyser.

Methods of Calibration

Before the pick-up can be used for the measurement of vibration it must be calibrated over an adequate range of frequencies. Methods of calibration can be broadly divided into two groups, viz., direct and indirect. Basically the technique of direct calibration involves subjection of the transducer to a known input motion by means of a vibration generator—generally referred to as the calibrator—and measuring the resultant response of the pick-up. It is required to know as accurately as possible the frequency and displacement of the generator motion. The former quantity is a relatively simple matter since the calibrator is usually of the electro-dynamic type driven by an oscillator. The latter quantity, however, presents serious problems which become increasingly difficult as the frequency rises beyond a few hundred cycles per second.

Mechanical methods generally involve large inertias and are therefore limited to low frequencies. Optical systems can be used over a wider frequency range. The best of these is to view the pick-up through a travelling microscope whilst freezing the motion by means of stroboscopic illumination. Still higher frequencies have been measured by interferometric techniques using the principle of Newton's rings. Among the indirect methods of calibration perhaps the most common is that of comparing the pick-up with a sub-standard. A more accurate method however is the "reciprocity technique".

Methods used at the Admiralty Engineering Laboratory

Of the many possible systems of calibration only three are used at the Admiralty Engineering Laboratory.

1. An optical method using a stroboscope and a travelling microscope.
2. A reciprocity method.
3. A comparator method.

It is not proposed to dwell here on the first of these other than to say that the method has been found to give good results up to 500 c/s. An accurate knowledge of cathode follower gain and the use of a high quality valve voltmeter enables the calibration of the pick-up to be expressed in terms of volts per unit acceleration. The second method covers the range above 500 c/s and for the benefit of those unfamiliar with the reciprocity technique it is the special object of this article to describe and explain the procedure in some detail. The third method is consequential on the other two which serve to establish a sub-standard unit against which other pick-ups can be compared. This is by far the easiest and quickest means of calibration. Although a considerable amount of work and care must be applied to the optical and, more particularly, the reciprocity systems, the benefits subsequently derived from thus setting up a sub-standard far outweigh the amount of effort involved.

Reciprocity Calibration of Barium Titanate Accelerometers

The method here described is due primarily to H. M. Trent[1], of the U.S. Bureau of Ships, and is presented in a form which it is hoped will be easily understood. To explain the procedure, use is made of a small amount of mathematics involving the mobility analogy method of treating dynamical problems. One does not need,

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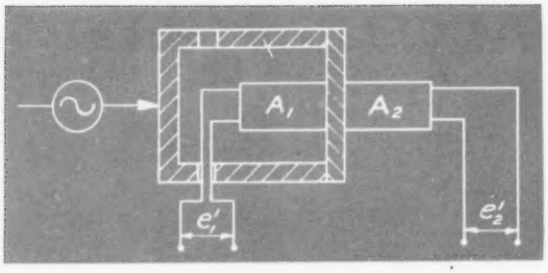


Fig. 1

however, to be familiar with this approach in order to carry out the calibration since it is only necessary to determine the quantities quoted later in equation (15) to obtain the required answer. Basically the procedure depends on the fact that when two reversible piezo-electric transducers are connected together and one is made to vibrate the other, an expression can be found for the overall mobility of the system in terms of the transducer sensitivities and the ratio of input current to output voltage. If now a relatively large mass is inserted between the transducers and the above procedure repeated a second expression for the overall mobility of the new system can be found in the same terms. Subtraction of one expression from the other yields an equation in which the mobility of the inserted mass alone is expressed in terms of these parameters. Finally, the application of a relationship deriving from the principle of reciprocity converts this equation into one in which the sensitivity of either of the accelerometers can be expressed in terms of the known mass, applied frequency, voltage/current ratios and pick-up sensitivity ratio.

It is seen that three experiments are involved:

(i) Determination of accelerometer sensitivity ratio.

(ii) Determination of overall mobility without mass loading.

(iii) Determination of overall mobility with mass loading.

Before proceeding further, however, the relationship derived from the reciprocity theorem will first be established. In this context the purpose of the calibration is to determine the sensitivity of the transducer as a voltage generator. This is defined as the ratio of the open circuit voltage to the velocity of the mechanical side.

i.e. $$S = \frac{e}{u} \quad \ldots\ldots\ldots \quad (1)$$

Where e = open circuit voltage
u = velocity of mechanical side
S = sensitivity as a voltage generator.

The transducer can also be used as a force generator and in this capacity its sensitivity is defined as the ratio of the force output to the current input with the mechanical side blocked.

i.e. $$G = \frac{f}{i} \quad \ldots\ldots\ldots \quad (2)$$

Where f = force output with mechanical side blocked
i = current input with mechanical side blocked

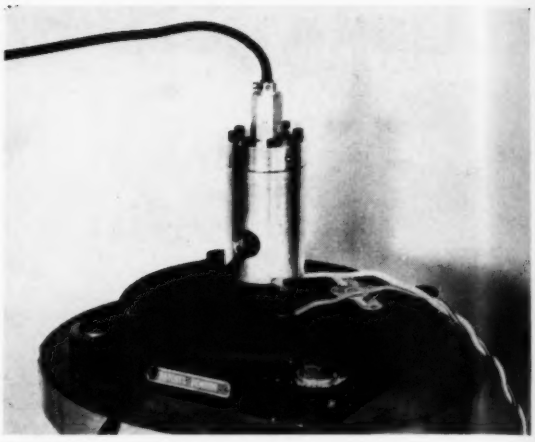


Fig. 2

G = sensitivity as a force generator.

But it can be shown by means of the electrical-mechanical reciprocity theorem that

$$ei = fu$$

i.e. $$S = \pm G \quad \ldots\ldots\ldots \quad (3)$$

The negative sign applies to an electromagnetic system and the positive sign to an electrostatic system.

(*i*) *Determination of Accelerometer Sensitivity Ratio*

If the accelerometers A_1 and A_2, having sensitivities S_1 and S_2 respectively, are rigidly attached to a vibrating element as shown in Fig. 1, and vibrated at frequencies over the range 500 to 20,000 c/s then it is easily seen from equation (1) that the ratio of their sensitivities can be expressed in terms of the ratio of their open-circuit voltages e_1' and e_2' respectively,

i.e. $$\frac{S_1}{S_2} = \frac{e_1'}{e_2'} \quad \ldots\ldots\ldots \quad (4)$$

That this is the first experiment is indicated by the

Fig. 3

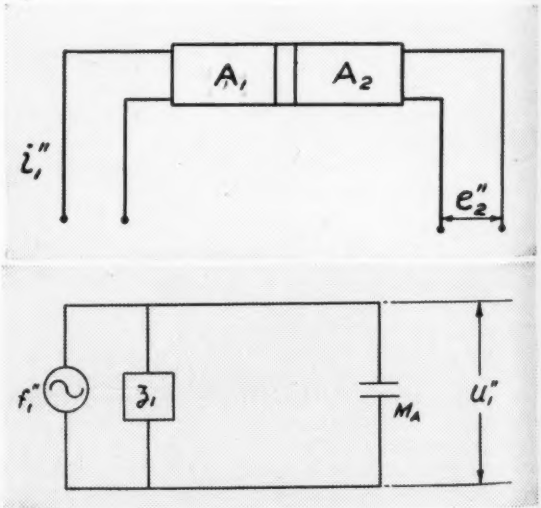


Fig. 4

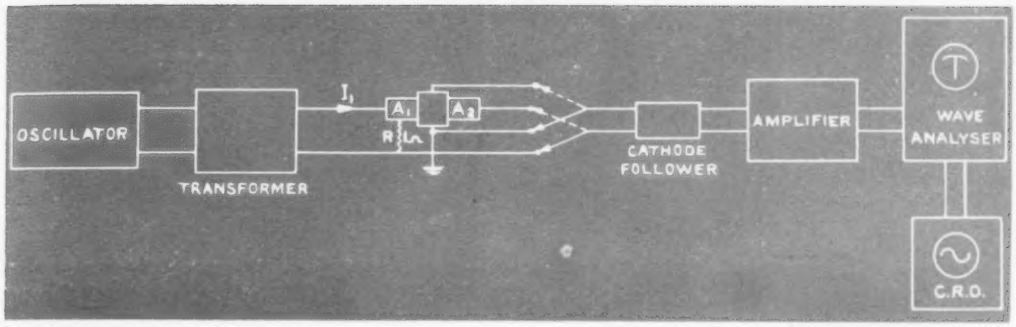


Fig. 5

single prime. Fig. 2 shows a photograph of the comparator unit mounted on a vibration generator. Third octave mid-point frequencies are found to give convenient intervals over the frequency range and it is emphasised that only the ratio of the voltage outputs need be measured. Since the discrete analyser is calibrated in decibels this ratio can be read off directly and will generally be of the order of a few dB.

(*ii*) *Determination of Overall Mobility Without Mass Loading*

This experiment is represented diagrammatically in Fig. 3. The accelerometers A_1 and A_2 are rigidly connected together by means of a small, light, aluminium linkage. With the system freely suspended as shown in Fig. 4 the pick-up A_1 is made to vibrate A_2 by means of an applied a.c. voltage. Under these circumstances a given input current S_1'' to A_1 generates a corresponding velocity u_1'' over the whole system and an open-circuit voltage output e_2'' from A_2. This experiment is denoted by double primes. By means of the mobility analogy such a mechanical system can be represented by the equivalent circuit of Fig. 4. In this diagram the transducer A_1 is symbolised by a force generator and a shunt mobility z_1 and the combined mass of the accelerometers and their linkage unit is represented by the capacitance M_A. The overall mobility of the system can then be written.

$$f_1'' = u_1'' \left(\frac{1}{z_1} + \frac{1}{z_A}\right) \quad \ldots\ldots (5)$$

Where $$z_A = \frac{1}{jwM_A}$$

But from equation (2)

$$f_1'' = G_1 i_1''$$

and hence (5) can be written

$$G_1 i_1'' = u_1'' \left(\frac{1}{z_1} + \frac{1}{z_A}\right) \quad \ldots\ldots (6)$$

From equation (1)

$$u_1'' = \frac{e_2}{S_2}$$

Which, when substituted in (6), gives

$$G_1 i_1'' \frac{S_2}{e_2''} = \frac{1}{z_1} + \frac{1}{z_A} \quad \ldots\ldots\ldots (7)$$

The only part of equation (7) which requires to be measured is the ratio i_1''/e_2'' and this is done by the system shown in Fig. 5. The pick-up A_1 is driven through a voltage transformer from the output of a decade oscillator. The current i_1'' is deduced from the voltage drop across the one ohm resistor in series with A_1. The voltage e_2'' is measured as for experiment (i). Here again it is emphasised that only the ratio is required.

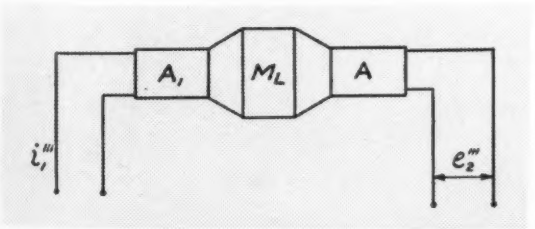
(*iii*) *Determination of Overall Mobility with Mass Loading*

Fig. 6 represents the conditions for this, the third and last experiment, denoted by triple primes. Here again A_1 is made to excite the whole system and for a given input current i_1''' there will be a corresponding velocity u_1''' giving a voltage output from A_2 of e_2'''. The equivalent circuit, Fig. 7, is as for experiment (ii) except for the additional mass loading symbolised by the capacitance M_L. The overall mobility of the system can now be written.

$$f_1''' = u_1''' \left(\frac{1}{z_1} + \frac{1}{z_L} + \frac{1}{z_A}\right) \quad \ldots\ldots (8)$$

Where z_L = mobility of additional mass $= \frac{1}{jwM_L}$

Fig. 6



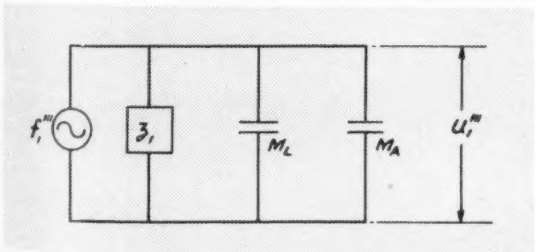


Fig. 7

again from equation (2)

$$f_1''' = G_1 i_1'''$$

and hence $$G_1 i_1''' = u_1''' \left(\frac{1}{z_1} + \frac{1}{z_L} + \frac{1}{z_A} \right) \quad \ldots\ldots (9)$$

From equation (1)

$$u_1''' = \frac{e_2'''}{S_2}$$

Giving

$$G_1 i_1''' \frac{S_2}{e_2'''} = \frac{1}{z_1} + \frac{1}{z_L} + \frac{1}{z_A} \quad \ldots\ldots\ldots (10)$$

In this equation i_1'''/e_2''' is the required parameter and the method of measurement is identical with that of experiment (ii). Fig. 8 shows a photograph of the instrumentation. The mass M_L with accelerometers attached can be seen in the centre of the picture. This mass must be accurately weighed.

Expression for the Sensitivity of Accelerometer A_1

Subtraction of equation (7) from equation (10) gives

$$G_1 S_2 \left[\frac{i_1'''}{e_2'''} - \frac{i_1''}{e_2''} \right] = \frac{1}{z_L} \quad \ldots\ldots\ldots (11)$$

i.e.

$$G_1 S_2 = \frac{jw M_L}{\dfrac{i_1'''}{e_2'''} - \dfrac{i_1''}{e_2''}} \quad \ldots\ldots\ldots (12)$$

But substituting from the reciprocity equation (3) and from equation (4) yields

$$S_1^2 = \frac{e_1'}{e_2'} \frac{jwM_L}{\left(\dfrac{i_1'''}{e_2'''} - \dfrac{i_1''}{e_2''} \right)} \quad \ldots\ldots\ldots (13)$$

This expression is in terms of velocity. The sensitivity of A_1 in terms of acceleration is given by

$$S_1 = \frac{1}{jw} \sqrt{\frac{e_1'}{e_2'} \frac{jw M_L}{\left(\dfrac{i_1'''}{e_2'''} - \dfrac{i_1''}{e_2''} \right)}} \quad \ldots\ldots\ldots (14)$$

Although this expression implies that S_1 has magnitude and phase, for most purposes only the magnitude is required. This can be obtained by dropping the negative sign and j from the equation.

If the m.k.s. system of units is used, the quantities measured will be in volts, amperes, kilograms, seconds and metres. S_1 is then given in (volts) $\times$ (metres)$^{-1}$ $\times$ (seconds)$^{-2}$.

Difficulties and Limitations

Reference to results recently obtained at the Admiralty Engineering Laboratory may serve to illustrate some of the difficulties and limitations of this method of calibration. The mass M_L should be about ten times that of the combined mass of the two transducers and their linkage unit. Strictly speaking M_L is equal to the additional mass less that of the linkage unit, but generally the latter is small enough to be neglected. On the other hand M_L must not be too large or it may absorb so much energy that the output signal C_2''' will only be detectable at high frequencies. Another important factor in this connection is illustrated in Fig. 9. The ratio i_1/e_2 for various mass loadings—including masses of accelerometers—are shown plotted against frequency. It can be seen that the larger the mass the greater is the deviation from linearity and that the curves converge towards 20 kc/s. In this region a sharp resonant peak occurs. The non-linearity is estimated by Harrison and Sykes to be due to a change in the effective mass which, at high

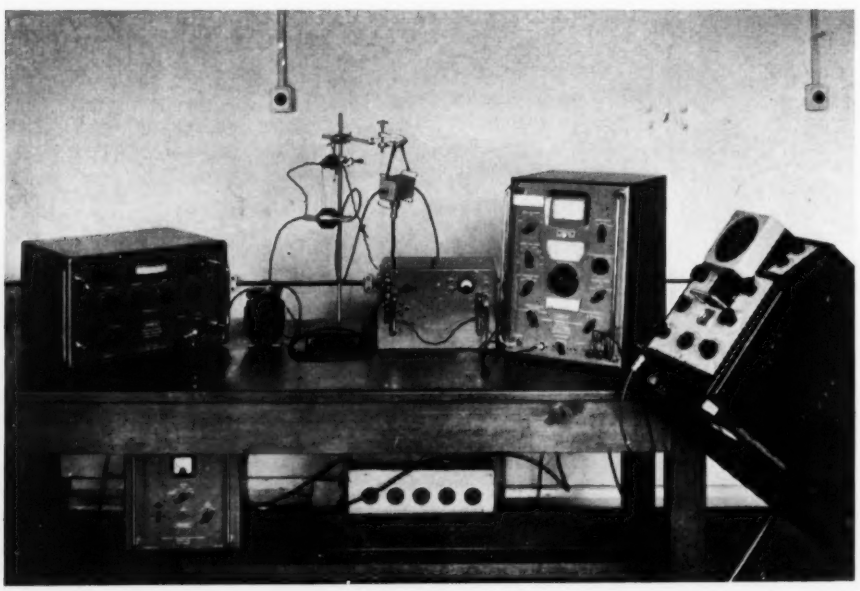


Fig. 8

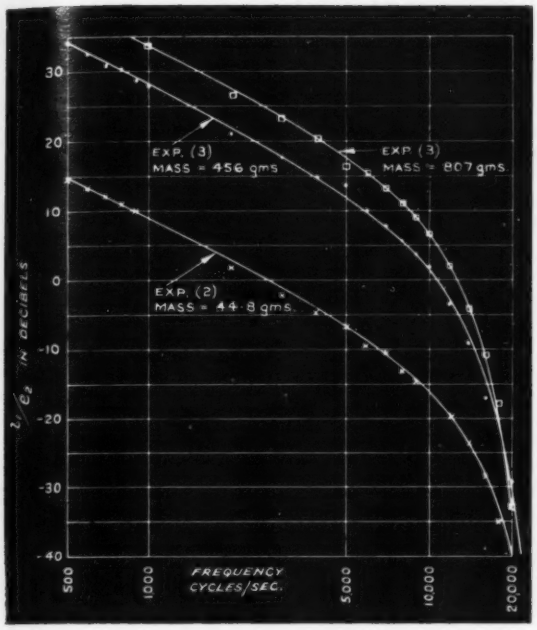


Fig. 9

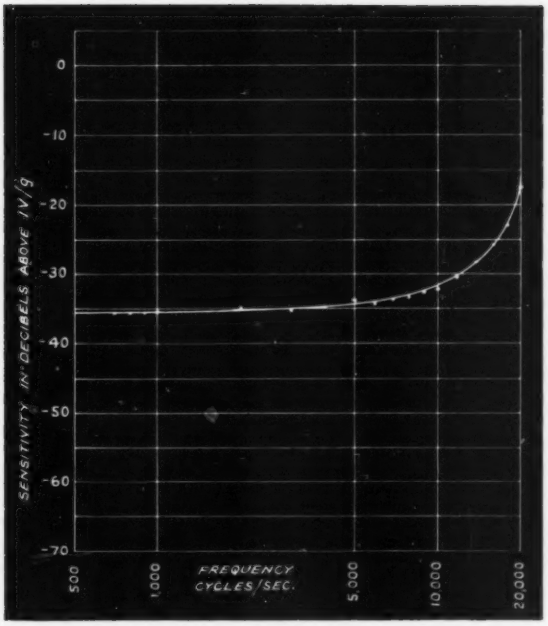


Fig. 10

frequencies, can no longer be regarded as a lumped impedance. Other major resonances were found in the vicinity of 34 kc/s, 48 and 68 kc/s. The natural frequency of the accelerometer is approximately 60 kc/s and the occurrence of a resonant peak as low as 20 kc/s seems rather surprising. In this connection it may be of some interest to note that two peaks were usually found near this frequency, one of them associated with the first accelerometer and the other with the second. Variations in the mechanical tightness of the metal contacts between the transducers and the mass load caused variation of the peak resonances over the range 18 to 24 kc/s.

Whatever the causes of this condition it represents a serious limitation to the frequency range of this method of calibration as can be seen from Fig. 10. Values above 12 kc/s can clearly be disregarded but the lower part of the curve is sensibly flat down to 500 c/s. This was as low as the instrumentation would allow, and since in this region the voltage applied to A_1 was about 270 volts it was feared that the higher values needed to reach lower frequencies might induce large linear strains in the barium titanate crystal. Since the optical method agreed with the reciprocity value to within 1% at 500 c/s it was felt this was an adequate meeting point for the two systems. A mass of 420 grams was used to obtain the calibration shown. Larger values did not result in any serious deviation from this curve except at frequencies above 10 kc/s. Using higher values of the resistance (e.g., 100 ohms) in the hope of obtaining more accurate readings did not result in any improvement on the one ohm condition.

One of the chief difficulties in setting up experiments (ii) and (iii) is that of electromagnetic coupling and earth loops. All leads, battery boxes, transformers, etc., should be carefully screened and the apparatus for driving the system kept remote from the measuring equipment. The system should be earthed at one point only, preferably at the transducer coupling as seen in **Fig. 5.**

Because of the small voltages and currents operating in the system and the need for using high gain amplifiers to measure them it is desirable to be quite sure that the signal from A_2 is genuinely due to the mechanical forces exerted by A_1. This can be demonstrated by separating the pick-ups mechanically while still maintaining electrical contact by means of a flexible lead. In this condition, for correct working, the output signal from A_2 should fall to zero. A further check may be made by inserting a linkage unit made of insulating material, such as tufnol, in place of the metal one.

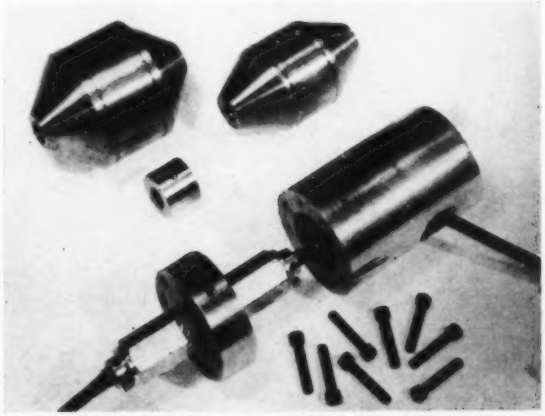


Fig. 11. *Exploded view of comparator and masses*

Another source of trouble which may occur when measuring the voltage output is a wave distortion due to the high resonant peaks referred to above. It is found that when driving at lower frequencies, such as 4 kc/s, very small harmonics of these frequencies are sufficient to excite the resonance in the region of 20 kc/s and higher. Such signals can actually exceed the value deriving from the primary low frequency wave and on a total level meter would obviously give rise to errors. Hence the need for a discrete frequency analyser and a monitoring c.r.o. In this way the unwanted signals can be detected and filtered out.

Conclusions

Some attempt has been made to give a useful and detailed account of a special system of calibrating accelerometers. Attention is drawn, in conclusion, to the fact that apart from the need to measure accurately M_L and the driving frequency, it is only required to determine the values of the three ratios quoted in equation (15). The equipment used is normally available in most physical laboratories. Taken in conjunction with the well tried optical technique referred to previously, the method enables the sensitivity of an accelerometer to be determined over a very wide range of frequencies.

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SYNTHETIC SAPPHIRE AS SENSING ELEMENT IN INFRA-RED DETECTORS

INFRA-RED detectors are used nowadays as sensing elements in radiometers, pyrometers, infra-red spectrometers, gas analysers, product control units, refractometers, missile guidance systems, and many other devices both in production and in the development stage.

The detector is the key element of the infra-red system whose main elements are these: an entrance window to admit infra-red radiation; an optical system to focus the infra-red waves; a sensing or detection device to convert the infra-red radiation into electrical energy; an amplification system; and a direct reading device, such as a cathode ray tube, meter, or paper chart recorder.

It is thus of the utmost importance that the sensing element be fast, rugged and sensitive. The heart of the sensing element or detector is the thermistor (thermally sensitive resistor) which is made of heat sensitive electrical semi-conductors. Two flakes of thermistor material are mounted on a housing. One unit is blackened and attached to a heat sink, in this case a sapphire heat sink. The other unit is shielded to provide a compensating element. The difference in voltage resulting from the decreased resistance of the exposed, active thermistor and the unvarying resistance of the shielded element can be amplified to set up a useful signal.

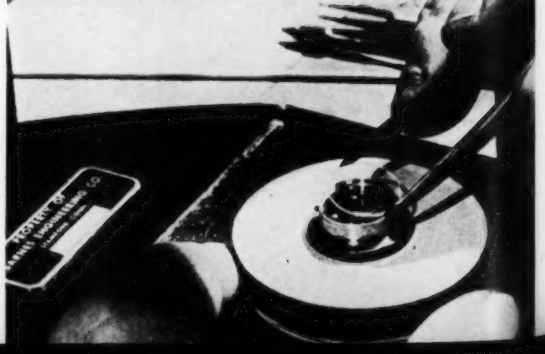
As a heat sink, sapphire made by the Linde Department, Union Carbide Corporation in the United States, provides high electrical resistance and high thermal conductivity—both important qualities for fast, sensitive response.

As a window, the same sapphire is used in detector applications which require transmission of the visible spectrum with a cut-off of about 6·0 microns in the infra-red band.

Sapphire has other unique characteristics which make it an ideal infra-red system material. At temperatures above 500°C, for instance, sapphire retains its infra-red transmission characteristics. No other transmission material known will continue to transmit portions of the infra-red spectrum at this elevated temperature or beyond.

Another unique group of properties which make sapphire most useful in this field is its strength at elevated temperatures and its corrosion and abrasion resistance. Other window materials fail because they are soft or easily attacked by moisture, acids and high temperatures.

Sapphire is readily sealed to metals and ceramics, thus it can be made part of any electronic assembly.



Linde sapphire window being fitted to a complete thermistor bolometer assembly prior to evacuation and sealing

INSTRUMENT MANUALS AND SERVICING

By E. G. KINGHAM, A.M.I.E.E.*

Introduction

IN former days the majority of instrument repairs were carried out by the manufacturer but it is now becoming common for many organisations using a large number of instruments to aim at providing their own service for installation and maintenance, and in some cases for advanced repair. This growing practice has resulted in a number of discussion sessions at the recent S.I.M.A. Convention at Harrogate, and this article puts on record the context of one such session. The topics under discussion were instrument instruction manuals with a secondary interest in servicing, and this article follows that trend.

At the Central Electricity Research Laboratories an instrument service exists which takes the form of an instrument stores containing a very wide range of differing types of instruments, any of which may be loaned to members of the staff.

A check is always carried out on all new instruments when they are received to verify their operation and compliance with the makers' specification. Immediately these points are satisfied, the instrument is allocated a number on a laboratory instrument list and labelled, usually with a metal stick-on label. Two copies of the relevant instructions are obtained for each instrument and one set of these is available for loan with the instrument to the scientific staff involved. This is made necessary by the widely differing experience of the personnel using the instruments, and the diversity of instruments encountered. The second set of instructions is placed in a reserve file held by the instrument engineer. The total number of instruments is at present some 1,300, and the nature of these varies enormously from complex electronic types to simple indicating instruments, covering a field of measurement and control of many differing aspects. In the great majority of cases the laboratories are equipped to be self-supporting in the field of instrument maintenance and calibration, and for this purpose an a.c./d.c. polar co-ordinate potentiometer, a wide range of substandard instruments, and similar test instruments, form the basic equipment of the Instrument Maintenance Group.

Instrument Manuals

It can be seen from the above description that the satisfactory operation of this type of work depends upon the experience of the personnel employed, together with the provision of adequate information by the manufacturers. It is the practice of some manufacturers to regard the instrument which they are producing as an entity in itself, with the result that if any instructions are subsequently produced these are often handled by the same engineer who developed the instrument, this in turn resulting in insufficient information being included. The production of an instrument manual of good standard and capable of being clearly understood is a specialised occupation in itself, and the combination of development engineer and technical writer in one person is seldom met. It is often erroneously thought that to produce good instructions is a waste of time and money since they are frequently mislaid by the user, or kept by some disinterested person. Whilst not denying the occasional truth of this, it is believed that adequate information concerning some instruments has never been prepared in a form in which it might be issued. In other cases, information and drawings do not exist at all. It is, of course, true that this lack of information is exceptional. In some cases, particularly where electro-mechanical devices are concerned, excellent information on maintenance and repair is provided. Nevertheless, adequate instructions are unfortunately uncommon and experience has shown that there are remarkably few manufacturers of, for instance, electronic instruments who produce instruction manuals of a really high standard. It is noteworthy also that where such a manual exists it usually goes hand-in-hand with an instrument of good design and first-class construction. Criticism of this nature is of course useless without details and for this reason, together with the fact that development engineers will no doubt have to continue to produce instrument manuals, it is intended to list a few of the faults most commonly found.

Manuals frequently fail to give adequate details concerning the principle and method of operation of the instrument concerned, providing only a sketchy outline of these factors. A full understanding of such principles is the first major step toward successful servicing. Circuit diagrams of both abridged and full circuit data are often of a poor standard and frequently use incorrect symbols in relation to the appropriate British Standard Specification (B.S. 530 : 1941). The layout of these diagrams often fails to lead to a logical tracing of the sequence of events. This matter is not helped when the diagrams are not capable of being folded out from the manual in order to permit reference to the appropriate written contents at the same time. Component values are frequently not given and a detailed specification of individual components is even more rare. The absence of space for modification entries causes errors and changes to be omitted. Layout drawings, and not layout photographs, facilitate maintenance to a very large extent. This is because photographs,

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although probably good in the first instance, often lose their clarity in the course of reproduction. In this respect, component references actually attached to the chassis at the relevant point are of even greater help. However, as always, criticism should be constructive instead of just destructive, and it is intended therefore to give below a list of the more essential factors that are considered to go towards making a good instrument manual. This list would be applicable to the electronic type of instrument which includes some proportion of mechanical equipment.

1. Brief general description of equipment as a whole.
2. Detailed description of:
   (a) Principle of operation.
   (b) Design considerations.
   (c) Power supplies.
   (d) Physical data.
   (e) Technical data.
3. Operation, consisting of installation, commissioning and use.
4. Routine maintenance and testing.
5. Servicing and fault finding (including test voltages and waveforms).
6. Calibration check procedure (including test equipment specifications).
7. Interpretation of results.
8. Accessories.
9. Pull out sheets of:
   (a) Block functional diagrams.
   (b) Principle of operation circuit diagrams.
   (c) Detailed circuit diagram.
   (d) Component specification.

The following points should also be considered in relation to 9. All component values should be stated on the circuit diagrams under (c) together with sufficient information under (d) to permit identical replacements to be ordered in advance. Wherever possible, the Interservice Catalogue Number should also be quoted. When there is more than one unit or chassis in an instrument, component references should not be repeated in such a way as to permit confusion. Circuit diagrams should be self-contained and self-explanatory whenever possible and should include such information as test voltages, typical waveforms, etc., and show clearly all interconnections to other equipment.

Although these recommendations may appear somewhat lengthy, it should be remembered that some of the items included will only require a few lines and thus such a manual may well be quite a small publication. This will, however, be finally decided by the complexity of the equipment more than anything else, and in the event of a manual becoming too large and unmanageable, the possibility of sub-dividing it into two or more smaller manuals presents itself. Each of these smaller manuals could deal with a particular aspect of the instrument, e.g., a separate volume dealing with routine maintenance and testing only. By issuing a single, more comprehensive volume, covering a wider range of the manufacturer's established products, the present duplication of manuals for a particular type of instrument could then be avoided. This would be of advantage to manufacturer and user alike. In all cases the manuals should be prepared in such a way as to allow the insertion of additional sheets whenever this is necessary and the bindings should be such as to permit the volume to be laid out flat on the bench and to remain so without weights being applied.

It has been said on many occasions, and certainly with some justification, that the preparation of a manual on the lines suggested above must incur a considerable cost and that this cost, when added to the price of an instrument, will have an adverse effect on sales. This may be so when tendering for large orders, but it should be appreciated, however, that the large user expects this information to be made available and, furthermore, is prepared to pay a reasonable price for it. A possible solution might be to sell comprehensive instruction manuals as a separate extra.

Servicing

At this stage it would be of advantage to consider briefly some of the more obvious points which simplify servicing.

A greater use of sub-units or sub-chassis is generally desirable, with plug and socket connections between these and the main body of the instrument. A more careful consideration of components, with a view to standardisation of Ministry approved types, would be of benefit to both the maker and user alike. For instance, the consistent use of special quality type valves (i.e., in the CV4000 series) will ensure greater reliability and that spares will continue to be available for many years to come. The slight extra cost incurred in this way may well be regained from the increased reliability obtained and the sales advantage to be gained in stressing these points in advertising. Even simple features such as the choice of one standard size of battery would greatly simplify matters from the point of view of carrying spares for a particular make. In an organisation using any variety of instruments the final range of batteries required may well cover almost the entire retail range, and this, of course, leads either to inefficiency or wastage. The marking of component references and test points on the units in a permanent manner is of great advantage to servicing, whilst the consistent use of lock washers and valve retainers has been known to solve many maintenance problems. The ability to partially withdraw a chassis for inspection or test and to have both hands free for this work is also a feature of considerable advantage in cubicle or rack mounted equipment. The provision of a circuit diagram of the unit permanently mounted on the unit itself is distinctly helpful and it is worth mentioning that printed p.v.c. sheet has many advantages over more conventional materials, including considerable resistance to abrasion and discolouration, retaining its legibility over long periods of time.

It will be appreciated that the points made above have been gained from service experience over a wide and diverse range of instruments. Manufacturers who choose to incorporate these suggestions, where applicable, are assured that they will indeed gain the commendation of instrument service engineers everywhere.

Acknowledgments

The author wishes to thank Dr. J. S. Forrest, director of the Central Electricity Research Laboratories, for permission to publish this article.

Fig. 1. Complete assembly

LOGGING AND MONITORING EQUIPMENT FOR CHEMICAL PLANT

The equipment described here provides temperature monitoring and data logging of a continuous chemical process at an Imperial Chemical Industries plant. It was built by Sunvic Controls Limited.

Introduction

THE complete assembly, which weighs approximately 4½ tons, is in three sections, with individual key switches, jacks, limit indicators, temperature indicators, and alarm lamps, all panel mounted in two wing cubicles (Fig. 1). The rear of each wing cubicle carries input relays and limit-setting potentiometers, and space is provided for portable limit-setting calibration gear.

The central cubicle contains the recorders, common apparatus, jumper frames and control units, and includes the logging printer. The alarm printer is mounted separately.

The complete equipment satisfies the requirements of intrinsic safety as specified by the Safety Research Establishment.

General Description

Information is derived from 440 chromel/alumel thermocouples, all within the range 0-300°C: these provide an output of approximately 0-12 mV. For monitoring purposes, any temperature can be displayed on either one or two potentiometric indicators, or, if required, a selection of temperatures may be recorded on the three 12-point potentiometric recorders.

For logging purposes, any of the 440 thermocouples' outputs can be routed to the logger, so that they are scanned every 15 minutes. The value of each point is compared with pre-set upper and lower limits, and any deviation shown in the print-out.

The output from each thermocouple is connected both to a manually-operated key selector switch and an automatically-operated input relay. This provides either temperature indication, or automatic scanning. Three circular scale indicators are fitted in each wing cubicle, the centre one showing the temperature of any point when the appropriate switch is depressed (Indicate). The indicators either side of this meter show high and low limits for the particular point.

When the key switch is in its mid-position (Scan), there are two alternative signal routes. One is through an input relay to the logger, the other through a jack socket to which may be connected one of three 12-point self-balancing potentiometric recorders. In the latter case, use of any jack plug automatically starts the chart motor of the appropriate recorder.

When the key switch is in the up position (Off), input from the point concerned is not subjected to the normal limit comparison procedure of the logging equipment. However, although no print-out action for the point takes place, an input signal is still available at the jack socket.

If a recorder jack is in use, or if a key switch is at "Indicate", there is no print-out action for that particular point, just as in the "Off" position. Nevertheless, the scanner dwells at the point for the allotted two seconds.

Each key switch is biased to return to "Scan" from "Indicate", but may be locked in the "Off" position.

Print-out

Two printing machines are provided. One is known as the log printer, and is housed in the scanner cubicle. The other, known as the alarm printer, is housed separately at a monitoring desk.

Both printers present data in a non-tabulated form on a 2½ in. wide continuous strip. The log printer, which is used to prepare a log at predetermined intervals, is

```
11M:26D:15H

31:Pe00:1334H
31:Pe01:133L
31:Pe02:133H

31:Pe03:134L
31:Pe04:135H
31:Pe05:134H

32:Pe06:132H
32:Pe07:133H
32:Pe08:133H

32:Pe09:134H
32:Pe10:134H
32:Pe12:135H
```

Fig. 2

fitted with an automatic guillotine which is brought into action at the end of each log. All temperatures are recorded; those in the alarm condition being in red and those within prescribed limits being in black.

Usually a log takes place every 30 minutes, that is, at each alternate scan. This is considered the "normal log". Alternatively, logging may take place at 15 minute intervals. This is known as "continuous log". A log always starts at an exact ¼ hour. A typical log printer strip would be:

Start of scan.				
Month. Day. Hour.	06M:	04D:	10H	(Red)
Two line space				
3 Test Inputs. (Same value	30:	TO1:	123H	(Red)
but different limits)	30:	TO2:	123	(Black)
	30:	TO3:	123L	(Red)
Each group of 3 followed by a one line space				
Data: Time (mins): Point No.	30:	Re21:	125H	(Red)
Value and Symbol	30:	Re22:	243	(Black)
	30:	RwO1:	198L	(Red)
Open Circuit: Value and Symbol = 000C	30:	Se17:	000C	(Red)
Decoder Fault: Fault digit	30:	1611:	512C	(Red)
Print 5, Symbol C	30:	7 22:	017	(Black)

End of log. Space not less than 20 lines, followed by a guillotine operating pulse.

Alarms

The alarm printer prints out the appropriate data only for those points found to be outside the preset limits. This machine is provided with manual paper tear-off.

On the alarm printer, the start of the scan, data presentation, and spacing is generally the same as that for the log printer, except that only information indicating the alarm condition is printed, and a 7 line space is left at the end of the scan, without any guillotine pulse. An example of scanning is shown in Fig. 2.

Symbols available in the fourth column are:—16, 17, 18, 19, Re, Pe, Rv, Se, Sw, T. Each of these symbols is the same width as one digit in any other column.

A neon lamp is provided for each point to give visual alarm if a point is outside limits. On detection of any off-normal condition, the neon lights, and stays alight until either the point returns to normal, or the alarm is cancelled. This affords visual display of all those points out of limits, in addition to the "off-normal" print-out. Should a key switch be put to "Indicate" or "Off", or a recorder jack be inserted, a change in condition is not detected by the scanner, and the neon becomes inoperative, remaining either lit or extinguished.

A manually-operated push-button is provided at the control desk to cancel all outstanding alarms. Any alarm still "on" will be detected and indicated again during the next 15 minutes scan.

A digital clock calibrated in 24 hours and minutes is fitted to give appropriate information to the print-out equipment. A visual in-line display of time is provided on the front panels with provision also for setting-up the numbers of the month and day.

Circuit Operation

Fig. 3 shows a schematic layout of the circuit. Primary measuring elements for all points are chromel/alumel thermocouples to I.C.I. specification H552C. Cold junctions of all thermocouples are held at a constant temperature of 45°C.

A scanner routes information through each input relay in turn to a common self-balancing potentiometer where the thermocouple signal is measured. The speed of scanning is two seconds per point on a fixed time basis, and the scanning cycle is synchronised to start at the ¼ hours.

The self-balancing potentiometer mentioned above carries a digitiser and re-transmitting slidewire for limit detection. The digitiser output is only used if print-out is required.

A jumper field is fitted (Fig. 4) so that the thermocouples can be presented to the common measuring equipment in any sequence. A special jumper is incorporated so that an "end of log" signal can be introduced as required.

Each thermocouple input has associated with it a high and low limit setting potentiometer. These are manually set against a portable unit consisting of two precision potentiometers calibrated over the full temperature range, together with associated null indicators. Thus, both limit potentiometers can be adjusted simultaneously.

For the purpose of alarm detection, a valve-operated detector compares the voltage derived from the re-transmitting slidewire in the self-balancing potentiometer with voltage derived from the appropriate limit potentiometers. Should an out-of-limit condition exist, an alarm signal is routed to the alarm printer and to the relevant neon.

Test Signals

For testing purposes, a known input can be connected to the first three input points. Limits for these

can be adjusted to give a high, normal and low print-out, the print-out routing being as for a normal input. Manual testing is provided by the selection of a "Test" condition, in which case automatic operation is stopped and the equipment is ready to accept test routines. In general, test facilities are provided so that the location of faults can be carried out on a unit-to-unit basis, and by the use of built-in test gear.

A normal test print-out would be:

Start scan.	06:	04D:	10H	(Red)
Point identity T00, value as set.	40:	T00:	184	(Black)
One line space				

False Code

The detection of an unused binary code will cause the digit concerned to be printed as **5**, and the symbol as C, in red. It will be printed only by the printer on which the information would have been displayed had the code been correct. Thus, should the machine concerned be the alarm printer, it will be known that the true value is outside limits, and the alarm neon will be lit normally. A lamp marked "False Reading" is also lit.

Emergency Operation

Should a fault occur on one printer, the other machine can be brought into operation to perform the complete printing programme. Each printer is controlled by a switch with three positions, "Off", "Normal", and "Emergency". The latter position causes the complete programme to be printed on the one machine.

A duplicate self-balancing potentiometer unit is built into the equipment with facilities for an easy changeover in the event of a fault.

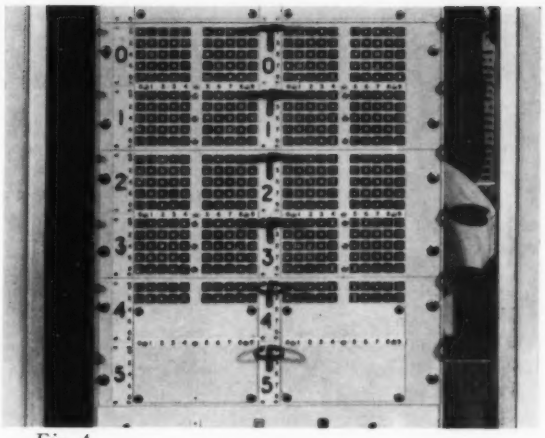
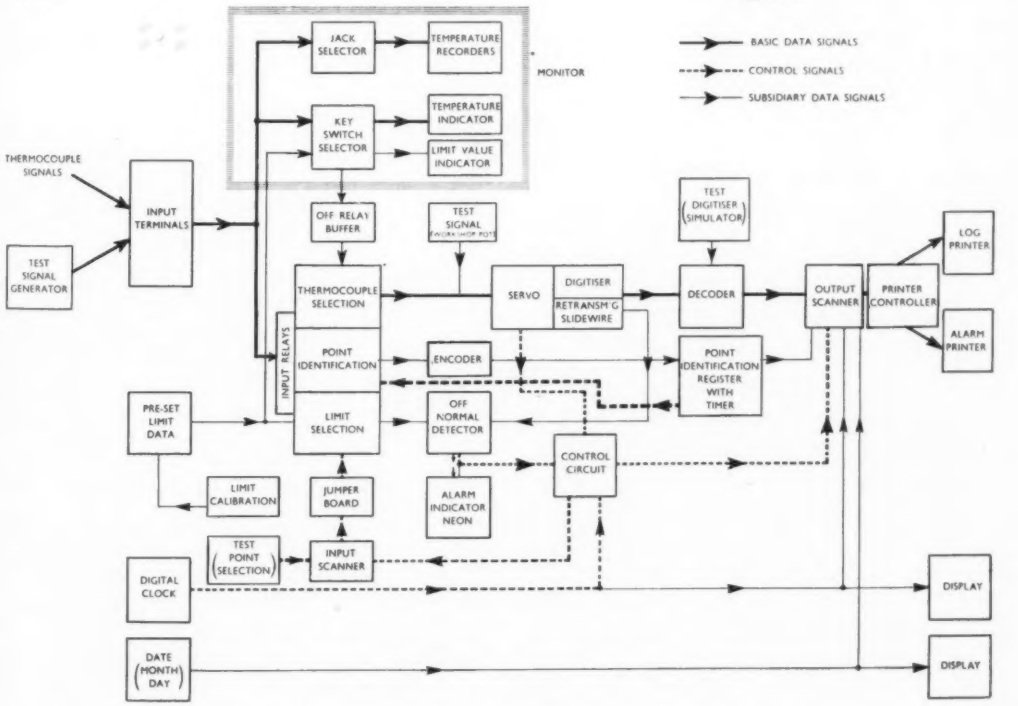


Fig. 4

Performance Data

Accuracy	The accuracy of the logging equipment is ±2°C.
Speed of scan	Two seconds per point, synchronised to start at the ¼ hours.
Logging intervals	Either ¼ or ½ hour intervals as required.
Limit setting	Both high and low limits can be set for each input point to an accuracy of ±1% of full scale.
Off normal detection	Off normal detection accuracy is ±2°C.

Fig. 3



MERL RESEARCH SUMMARIES

The following are summaries of reports and notes available from the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

Effects of Swirl in Pump Testing

Misleading performance characteristics may be obtained if there is rotation or swirl in the flow at the inlet or outlet of a pump when it is being tested. A simple method has been developed to detect and eliminate errors due to swirl.

The head across a pump is usually determined by measuring the static pressure at points close to the inlet and outlet. When swirl is present the head obtained from these readings may be appreciably different from the true head. The error can be allowed for if it is possible to find a tapping point somewhere in the circuit which is free from flow irregularities. By plotting the square of the flow against the difference in head between this reference point and the usual static-pressure point, any errors due to swirl are shown up as deviations from an otherwise straight line.

If errors in head arising from the presence of swirl are not allowed for, misleading head/flow characteristics will be obtained and the results may suggest, incorrectly, that the pump is unstable at low rates of flow.

It is recommended that this method should be tried out in the field and at other installations for testing pumps or turbines.

Further information is given in: *MERL Fluids Note* No. 54, available from the Laboratory.

Measurement of Water-turbine Efficiency

A method which can be used to provide a continuous check on the efficiency of a water-turbine, without interrupting the normal running of the hydro-electric station, has been tried out for the first time in Britain. It is much simpler than other methods and is also likely to be suitable for acceptance tests.

The principle of the method is that, since the energy losses are converted into heat, the rise in temperature of the water flowing through a turbine may be used as a measure of its hydraulic efficiency.

This principle can be applied in two ways. In the thermometric method the temperatures at inlet and outlet are measured directly, but this requires accurate absolute calibration of the two thermometers.

In the thermodynamic method a sample of water is drawn from the penstock and expanded adiabatically in a calorimeter until its temperature is raised to that of the water in the tail-race. The thermometers need to be matched carefully but absolute calibration is not necessary. Accurate measurement of pressure is needed in both methods.

The temperature rise, which is proportional to the head across the turbine, is of the order of 0·025°C for a 300 ft head machine. Equipment which is sufficiently sensitive to detect such a small temperature change, but also robust enough for use in the field, has been developed for the thermodynamic method; a manometric piston-gauge which will measure pressure to an accuracy better than one part in 3,000 has also been constructed.

This apparatus has been tried out at two hydro-electric stations (with heads of 490 and 365 ft) and the best positions for the sampling probes have been investigated. The equipment worked satisfactorily and is, at the moment, suitable for efficiency measurements at medium- and high-head installations.

Further information is given in: *MERL Fluids Report* No. 70, available from the Laboratory.

Measurement of Vibration Amplitude

Equipment has been developed for the direct measurement of peak-to-peak amplitude of mechanical vibrations. Its frequency range is from 0 to 4 kc/s but it is particularly suitable for use at frequencies below 50 c/s; it can conveniently measure vibration amplitudes down to 0·000,02 in.

A linear grating is attached to the vibrating part and a similar fixed grating is arranged close to it so that the lines on the two gratings are not quite parallel. Interference bands, known as moiré fringes, are produced. When there is movement between the gratings in a direction at right-angles to the lines, the fringes move through one fringe spacing as the gratings move through one line spacing.

If the gratings are suitably illuminated, the movement of the fringes can be detected by photo-electric cells. Amplified signals from these cells are applied to a cathode ray oscillograph in such a way that relative movement of the gratings traces a circular arc on the oscillograph screen. The angle subtended by the arc of the circle is directly proportional to the amplitude of vibration; the arc just closes to a circle when the amplitude is equal to the spacing between the lines of the gratings.

Dynamic calibration is unnecessary since the accuracy of measurement depends only on the accuracy of the gratings and is independent of fluctuations in mains voltage.

The instrument can also be used to measure small displacements.

Further information is given in: *MERL Report Mech/Met* 125, available from the Laboratory.

FUTURE TRENDS IN INSTRUMENTATION AND CONTROL IN THE COAL MINING INDUSTRY

By

A. E. Bennett, B.Sc., A.M.I.E.E.*

COAL MINING is the largest single industry in this country. One in thirty of Britain's workers is a miner, and the present deep mined output is equivalent to over six tons a second of every hour of every day of the year. What then are the instruments in use in this gigantic enterprise?

To answer this question it would be necessary to study in detail the various aspects of the National Coal Board's work. These include the major undertaking of extracting the coal from the seam, its transport to the surface of the colliery, the subsequent washing and cleaning that is necessary before it is sent to its various users, and the very large carbonisation subsidiary with its associated production of chemical by-products. The various processes through which the coal passes once it is on the surface call for different types of instrumentation to that used underground, and papers and articles have been written covering this work, but very little has been published on the use of instruments underground. The object of this paper is to broadly outline the present position with regard to those instruments that are now being used, and to indicate what are likely to be the future trends in underground instrumentation.

No reference will be made to the design, operation and automatic control of modern electric winders, which are adequately covered by published literature[1].

Existing Instruments

The majority of instruments now in use are still those that were immediately available after nationalisation. There are very few types and almost all are connected with the safety of the colliery and not with the production of coal.

(i) *Safety Instruments*

Of the various parameters that have to be measured due to statutory responsibility, probably the most important is that of methane concentration in the airways. For this measurement the gas testing flame safety lamp (in effect the Davy lamp) is still the standard instrument (some 80,000 or more are in use). The basis of its operation is the burning of the mine air in the flame of the lamp which results in a blue cone appearing over the flame, the height of which is proportional to the amount of methane present. The accuracy of reading depends not only on having the wick of the lamp correctly adjusted, but also on the personal assessment of the miner taking the reading. Further, since the lamp has to be held at eye level whilst taking a reading, difficulty may be encountered when attempting to obtain a measurement at the roof of a roadway which may be six or more feet high. If a really accurate measurement is required then it is necessary to obtain a sample of mine air in a bladder or evacuated bottle and take it to the surface for chemical analysis. The gas testing lamp is of course a spot reading instrument and there are no continuous monitoring or alarm units in general use anywhere in the industry.

Respirable dust measurement is also of prime importance and this is obtained by the use of thermal precipitators[2], the dust being deposited on a microscope slide which is mounted approximately 0·005 in. from a heated wire as the mine air is drawn across the slide. The measurement of the sample is carried out by counting with a microscope those particles which lie within the range $\frac{1}{2}$ to 5 microns, and to ensure that the slide does not become so thickly covered that it cannot be counted, it is necessary to limit the maximum sampling time to approximately 10 minutes. Consequently, if an accurate assessment is to be made of the working conditions a very large number of samples must be taken. The N.C.B. currently makes approximately 320,000 tests a year, and even so this only covers the taking of spot readings at relatively infrequent intervals.

The control of ventilation is achieved by the use of anemometers and the measurement of the cross-sections of the roadways, involving periodic surveys through the pit. The area of the roadway section is particularly difficult to obtain as the shape is highly irregular.

Humidity and temperature are measured by the use of conventional non-recording instruments on a spot reading basis.

The detection of carbon monoxide in the case of an underground fire is still dependent upon the use of canaries or the chemical analysis of samples of air taken to the surface.

(ii) *Production Control Instruments*

A limited number of electrical testing instruments such as insulation testers are in use, but the position with regard to production control instruments is that to all intents and purposes there is no means of telling whether a face is working efficiently other than by visual observation and the relative comparison of the day-to-day output from the face.

* Assistant Director, Mining Research Establishment.

Current Developments

This was the position that existed when the Mining Research Establishment was formed and consequently since then one of its tasks has been to develop models for general use by the industry, as well as providing special research instruments to enable its staff to carry out underground investigations. Considerable progress has been and continues to be made in this direction, but much remains to be done before the industry can be said to be really taking advantage of all the benefits that can accrue from the installation of modern production control techniques, which of course in turn depend on well designed instruments and instrumentation. The progress that has so far been made is as follows:—

(*i*) *Safety Instruments*

To remove the personal element from the measurement of methane it was decided to design two instruments. One a direct replacement of the existing gas testing lamp, in which the miner would not have to use his personal judgment, and the other a continuous monitoring instrument that would run unattended for a period of at least a week.

Several basic physical properties which could be used to measure methane have been investigated and the following table gives for each technique the % change in signal that occurs when 1% by volume of methane is added to air:

1. Gas temperature above a flame ...	16%
2. Resistance of electrically-heated filament on which methane is burned catalytically	3
3. Volume or pressure change on combustion	2
4. Density	0·5
5. Refractivity	0·5
6. Thermal conductivity	0·2
7. Velocity of sound	0·25
8. Viscosity	0·4
9. Infra-red transmission	0·3

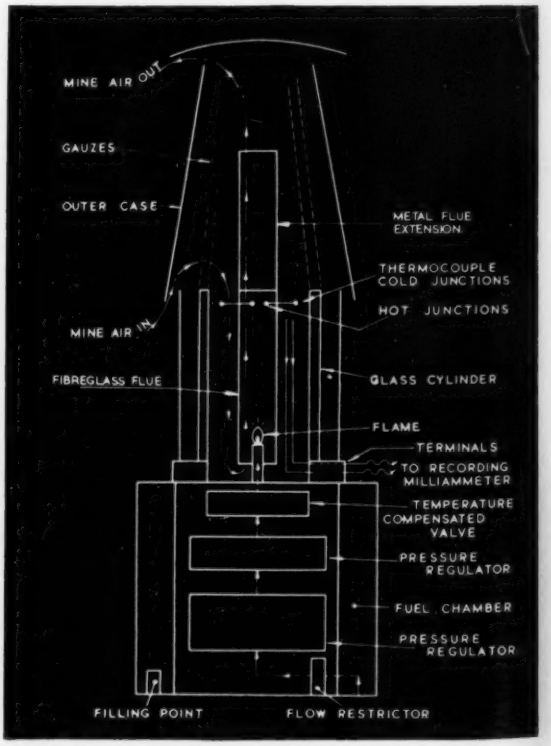
As the burning of methane gives by far the biggest response it was decided to use this method.

Thus the instrument that has been evolved is basically similar to the Davy lamp but the detecting element is now a ring of thermocouples mounted above a very accurately controlled flame[3]. In the first instance an 8-day recording instrument, shown in Figs. 1 and 2, is being produced, the output of the thermocouples being displayed on a milliammeter pen recorder. This model will first be used to collect basic information on the variation of methane concentration at various points underground. An alarm unit has also been designed to replace the recorder as desired. The development of this methanometer is now in the hands of a manufacturer and it will shortly appear as a production instrument. A transducer has also been designed which will enable remote indication of the methanometer output to be made over long lines.

A lightweight portable methanometer of similar size to the existing gas testing lamp is also almost ready for production development. As in the recording instrument, thermocouples are the detecting elements,

Fig. 1. *Eight-day continuous recording-flame methanometer*

Fig. 2. *Schematic diagram of recording-flame methanometer*



whilst the display unit is a conventional milliammeter which can either be mounted on the instrument or held in the hand whilst the methanometer proper is placed in inaccessible places, such as holes in the roof, etc.

A major improvement in the assessment of dust in mine atmospheres can be achieved if it is possible to sample continuously throughout the working shift. Since, however, the limit of dust concentration, as agreed by the Ministry of Power, National Union of Mineworkers, and the National Coal Board, is set at present at a maximum of 850 particles per millilitre, in the range of $\frac{1}{2}$ to 5 microns, the sampling instrument must be in a form such that the dust collected can still be counted on a microscope. For this reason it was decided that the new sampler would again use the principle of thermal precipitation and that it would be designed to run continuously for a period of eight hours. To achieve this it is necessary to remove the larger non-respirable dust particles from the air that enters the instrument before it reaches the microscope slide. This is done by means of an elutriator (size selector) designed to collect almost all the dust above 5 microns in size. The instrument that has evolved is shown in Figs. 3 and 4, and has been described by Hamilton[4]. It uses a small diaphragm type of pump operated by a powerful clockwork mechanism to draw the mine air past the thermal precipitator wire. Quantity production is now in full operation.

Fig. 3. *Long running type dust sampler Type* 101*D*

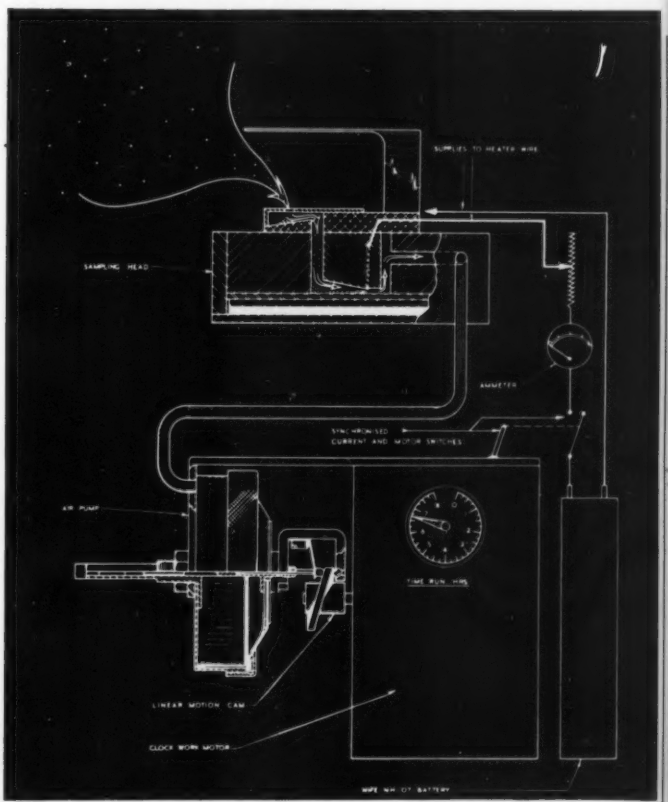
The introduction of this continuous sampler will enable the Board to obtain a more efficient assessment of coal face conditions, but considerable time and consequently money will still have to be spent on counting the samples that are collected. To effect any economy and still maintain the improved dust monitoring routine, a densitometer has been designed for use with the new sampler, which will reduce or even eliminate the laborious counting procedure, but before it can be introduced agreements will have to be obtained to a change in the form in which the standard of dust concentration is expressed, i.e., from a number of particles per millilitre to a densitometric expression.

In the field of ventilation measurement, an instrument has been devised which will greatly facilitate estimation of the cross-sectional areas of irregular shaped roadways. With this new tool, called a Profilograph[5], an accurate but reduced section through a roadway can be drawn on a sheet of paper by merely following the outline of the road with a pointer attached to the instrument by an extensible cord. A remote reading anemometer is also being developed by a manufacturer.

A new type of intrinsically safe recording wet bulb thermometer employing a thermistor as the detecting element has also been developed and found to be very successful.

An instrument[6] for assessing the concentration of

Fig. 4. *Schematic diagram of N.C.B./M.R.E. dust sampler Type* 101*C*



carbon monoxide, designed by the scientific department of the North Western Division of the N.C.B., has now reached the stage where quantity production can be undertaken. It is based on the measurement of the amount of heat evolved when carbon monoxide is oxidised to carbon dioxide, and by using transistor techniques has been made intrinsically safe.

(*ii*) *Production Control Instruments*

Progress in this field has so far been limited to the development of a number of strata control instruments, designed for use by production staff to obtain a better knowledge of the performance of pit props, supports, etc., that are used to hold up the roof at the coal face. Strictly speaking, they are not control instruments in the currently accepted sense, rather they are tools which will give the necessary information that must be obtained before control can be introduced. They include a 50 ton load cell, with the interesting feature of being independent of the manner in which the load is applied, i.e., distributed, point, or strip loading can be put on either or both faces of the cell without affecting the accuracy of reading. This is necessary since if a load cell is placed between a pit prop and the roof it is generally not possible to arrange how the load will come on to the cell, due to the very irregular shape of the roof and the top of the prop.

A similar type of instrument has been devised for measuring the tension on long steel bolts that are used to bolt layers of rock together, and a strain gauge extensometer has been introduced to measure the changes in strain in the roof as the coal is extracted. Measuring units for use with these instruments include transistor operated equipments which are intrinsically safe and consequently light in weight and portable. It is worth noting at this point that conventional electronic measuring equipment cannot be used underground unless it is in a flameproof enclosure, which means the use of large and heavy steel boxes that can only be moved with considerable difficulty.

Dynamometers are also being designed which will indicate the loads that are being taken by the stone packs built to form the sides of roadways.

Long-term Instrumentation Schemes

Although, as indicated, new instruments are now coming into use underground, the overall position as regards production control is still very much the same as existed when nationalisation took place. Considerable thought has, however, been given to the possibility of introducing modern control techniques into this old industry and to assessing if in fact they would bring increased operating efficiency and consequential economic improvement. This problem presents many interesting facets of which two of particular note are remote indication and automation.

(*i*) *Remote Indication*

The value of the equipment on a fully mechanised coal face may well be as high as £100,000, and most modern pits will have a number of such faces. No large industrial organisation would ever think of working plant as expensive as this without knowing whether it is running efficiently, and it is therefore contended that one of the chief aims of the future must be the provision of remote indication equipment that will show at some key point underground (say pit bottom) and possibly on the surface, what is happening at the coal faces and in the roadways. In fact, the need is greater than that of any other industry, because of the inaccessibility of the equipment, some faces may be a number of miles from the pit bottom and it is not uncommon for a production unit to be stopped and for some time to elapse before the management becomes aware of the situation through preoccupation with other duties, possibly at a remote part of the pit. These frequent breaks in production can add up to a considerable amount of lost time. This situation could obviously be improved if better communications were provided underground, for example, replacement of the existing party line working and code ringing by a modern automatic system with a limited number of extensions (at present there are often up to eight or more phones in parallel). It would, however, only bring limited improvement, and considerably increased benefits could be obtained from the installation of a comprehensive remote indication system. Preliminary considerations have shown that it would be possible to give continuous indication of:—

1. The output, in tons, on the conveyors at various points in the pit, by installing weighing sections in the conveyor structures.
2. Whether or not a machine is cutting coal or merely idling, by displaying the electric power consumed by the driving motor.
3. An indication of whether or not the motors at conveyor belt transfer points, conveyor driving heads, etc., are running correctly, by measuring the electrical power consumed and checking the temperature of bearings, and driving drums, etc.
4. The methane concentration at the return ends of faces, which would check the condition on the face, and at strategic points in the roadways.
5. The state of the ventilation system, i.e., whether short circuits have been introduced into the network of airways due to leaving doors open, and badly fitting doors, etc.
6. The state of compressed air system, i.e., detection of losses due to leaks, caused by joints in the pipe working loose, and accidental failure to close valves, etc.
7. In the case of pits working a methane drainage system, the concentration of the gas at various points in the pipe system to check that neither pure methane is leaking into the roadway, nor air being drawn into the pipe range.
8. In special cases the load taken on supports, roadway arches, etc., at some particular points where exceptional difficulty is being experienced and constant watch has to be maintained on the conditions.
9. The flow of coal from the various conveyors or mine cars to the pit bottom storage point, and its rate of feed into the shaft cages or carrying skips.
10. That the power has been switched off to various

districts in the pit at weekends or other periods when portions of the pit are not being used.

The questions that spring at once to the minds of managers when this subject of "remote display" is raised are what would be the cost of installing such a scheme, and how much saving in running costs or equivalent production would ensue? The first part of the question can be answered with reasonable accuracy and readily understood. The principal cost would in fact be that of the cable required to connect the various transducers to the central point. No scheme has as yet been planned in detail, but it is unlikely that the total cost would exceed £20,000, which is less than the price of two of the larger types of coal cutters. The answer to how much will be gained is much more intangible and consequently considerably more difficult to accept. The obvious advantages which come to mind are better deployment of personnel and consequently better maintenance; men could be directed more readily to breakdowns and potentially difficult spots. It would also greatly facilitate an increase in "preventive" action and this in turn would reduce the total number of breakdowns and thereby cut down delays and consequent expensive standing time. Until some practical experience is obtained only vague figures can be given, but assuming a pit head price for coal of £4 per ton, it would only be necessary to save a loss in production of 5,000 tons to recoup an initial capital outlay of £20,000, and the annual production of a large colliery may be anything between 0·5 and 1·3 million tons, i.e., save 0·1% or less of one year's output. Similarly, the saving in the cost of electric and steam power which is being wasted due to leaks in the compressed air main may easily be equated to the original cost of the system. Even cursory studies of its application in other industries will also show that it can result in considerable economies, principally as a result of saving in what are, at present, hidden losses in time, the most important item of cost today in practically every industry.

At the moment two simple remote indication schemes are in operation but in both cases they have been installed on the grounds of increased safety and not production control. They merely give an indication of whether a machine is running or not, and if the power is switched on or off to a district. The first system at Warsop Colliery uses a multi-core cable, each monitoring point having its own pair of wires. The second installation at Merry-Lees Colliery[7] is more sophisticated, using a single coaxial cable into which is fed the output of a number of crystal controlled transistor oscillators switched on and off by contacts fixed to motor starters, etc. The oscillators are set at 250 c/s spacing in a frequency band of 60 to 100 kc/s and the signals are filtered out, on the surface of the colliery, to give the individual operation of indicator lamps. Useful general operating experience is being obtained from these very elementary installations.

Efforts are being made to "sell" the idea of remote indication and control to the industry, but progress is slow, since it is easy to see the cost of the project but very hard to realise that the capital outlay would very soon be recovered.

(*ii*) *Automation*

The use of remote indication would undoubtedly bring great increases in operating efficiency, but considerably further gains may well be had from the introduction of some form of remote control or automation. This may at first sight appear to be ridiculous, if not impossible as far as coal mining is concerned, but a closer examination shows that this is not the case and in fact the need for it is as great, if not greater, as in any other industry of comparable size. Some of the reasons for its introduction, not necessarily in the order of importance, are:—

1. The actual extraction of coal is a dangerous, dirty and most unattractive job and it is therefore logical and highly desirable that if it can be done by an unattended machine it should be done so as soon as possible.
2. Since thinner seams are having to be extracted, the amount of working room at the face is getting smaller, and machine handling problems continually increasing in difficulty. So some measure of sensing and remote control is needed to ensure that the coal cutter stays in the seam and does not cut the stone in the roof and/or the floor.
3. Experience with existing machines has shown that the factor limiting the rate of advance is not the machine nor the roadway conveying system, but the rate at which the roof supports on the face can be moved to keep open the working space.
4. It would permit the setting up of long, highly economic, faces which could be worked on a 24 hour continuous basis, e.g., one possibility would be to prepare a large area of coal by driving the roadways out to the underground boundary of the pit and then to remove the coal on a retreating basis as a continuous process, until all the coal in that area had been removed. By this means effort could be concentrated on to a small number of highly productive working faces, instead of the simultaneous operation of a much larger number of units worked on one, or at the most two, shifts per day.

It should not be thought that remote control promises to be the panacea of all ills. There is no doubt that mining conditions in some pits or areas will not be suitable for its introduction; there will always be the need for conventional manually-controlled machines as we know them, and it may well be necessary to send men into "man-less" faces to carry out maintenance, but it is contended that "man-less" mining must and will be introduced, and that there is a very big future ahead for it.

If remote control is to be introduced, what are the instrumentation and control problems that must be considered, and how should it be introduced? The first and prime aim is the withdrawal of all men off the working face and the control of the machine and the face supports from the roadway. To achieve this it would be necessary to:—

1. Know where the machine is with respect to both the roof and floor of the coal seam.
2. Control the movement of the machine to always keep it within the coal.
3. Know the position of the machine with respect to the road at either end of the face and to maintain

its path across the face in a straight line between the two roads, and keep the advance the same at all points on the face.

4. Indicate the condition of all the supports, i.e., what loads they are taking; how far they are from the conveyor, and therefore the face; and also control their movements.
5. Control the movement of the conveyor.
6. Introduce some form of cabling handling machine which will pay out and take in the cutting machine's power and instrument cable as it moves along the face.
7. Indicate the load (power) being taken by the various electric motors and stop the production unit should any preset limits be exceeded.
8. If an advancing technique is being worked, i.e., the roads are being cut as the face moves forward, some form of mechanised stone cutting machine will have to be developed as the existing manual practice is already at times a bottleneck, and will definitely be a key factor if rapid rates of advance are to be achieved.

Although the "man-less" face has not yet reached the stage of being co-ordinated as a single project, considerable preliminary work has been done on various aspects of it as parts of other programmes of work. Progress made in the following fields of (i) coal sensing and guidance, (ii) mechanical development of powered supports, and (iii) control and remote indication, is as follows:—

Coal Sensing and Guidance

The first object of this project is to develop some means of indicating to the operator of a mining machine the distance between the cutting tool and the boundary between the coal seam and the underlying rock, so that he can avoid running the cutters into the rock, thereby causing damage to the machine. This problem is of particular importance in thin seam working where the operator may be at one end of a machine 14 ft long, with the cutting heads at the other end, and the only illumination being that provided by cap lamps.

A nucleonic back-scattering technique[8] is being developed in which the gamma rays from a radio-active source are directed to the coal/stone boundary and the resulting scattered radiation detected by a geiger counter mounted adjacent to the source, but shielded from it as far as direct rays are concerned. It is expected that it will be possible to detect when the machine is within $1 \pm \frac{1}{2}$ inches of the stone boundary. Transistor electronics combined with potting techniques are being used to make the equipment rugged, light in weight, and intrinsically safe. Initially, meter indication will be given to the operator so that he will be able to tilt the machine with respect to its axes which are parallel to the floor, as well as being able to raise or lower the complete machine. This equipment is now ready for its underground trials and when they have been successfully completed, work will proceed with the replacement of manual control by electro-hydraulic servo mechanisms. Having achieved this, the final stage of controlling from the roadway will then be undertaken.

Mechanical Development of Powered Supports

When a coal face is being extracted by hand with men all the way down the face, it is easy for the men to set new props in the area where they are working without unduly delaying operations. But with the advent of mechanised mining with machines moving quite fast along the face (up to 18 ft per minute for machines taking cuts in the order of 2 to 3 ft in width, and up to 80 ft per minute for machines taking shallow cuts of approximately 6 in.), setting of props becomes a factor that limits the speed of advance. This problem cannot be overcome by merely putting more men on to the face, as there is only a limited amount of room in which they can work, and further, excessive use of manpower greatly increases production costs. The solution to this problem is the introduction of the powered or self-advancing support, which is in effect an assembly of props and roof bars energised by hydraulic power. Fig. 5 shows a face with individual props; Fig. 6 a face fitted with one form of self-advancing roof supports. The roof bars of the unit generally extend over the face conveyor, giving free access for the movement of the machine. Control is effected by the operation of simple valves mounted in the base so that the complete support arrangement on a section of the face can be moved by a single miner. The support can also be made to push the conveyor up to the coal face after the machine has taken a cut. The basic design and experience encountered with powered supports has been described in detail by Adcock and Wright[9].

At the present time there are over 6,000 coal faces in this country. On about 900 of these, coal is power loaded on to the face conveyor, and of the 900 at the end of 1958, only 34 were supported solely by powered supports.

Control and Remote Indication

Concurrently with the gradual introduction and further development of the powered support, the Mining Research Establishment is devising schemes for their remote operation, including both full hydraulic control, with automatic sequential energisation of successive supports, and electro-hydraulic control of individual supports. An underground pilot experiment with a number of supports is now in progress.

Work is also proceeding on a remote display system to be mounted in the gate road which will show:—

1. The hydraulic pressure in the legs of the support.
2. That the support has been set correctly.
3. How far the support is from the conveyor.
4. If the support has fully advanced itself.
5. In graphic form a "picture" of how the supports are set with respect to each other in the section of the face that is adjacent to the machine at any one time.
6. The position of the cutting machine with respect to the roadway.
7. Miscellaneous items such as hydraulic feed pressures, levels of oil, position of various guards and safety trips, etc.

Again parts of the system are being tested in actual underground conditions.

Fig. 5. Face supported by single props

Fig. 6. Face supported by self-advancing powered supports

Some thought has also been given to the possible use of closed loop television as a means of examining the state of the support system before sending men into the face to carry out maintenance work, but this is being held in abeyance until actual operating experience has been gained.

It is now clear that the time is approaching when it will be technically feasible to set up an experimental "man-less" face and thereby bring to light those problems and operational difficulties that even the most careful design studies cannot envisage.

Conclusions

It hardly needs to be stated that, in attempting to give an overall picture of the underground instrumentation problems of the National Coal Board, it has not been possible to go into technical details, these will be described in individual future papers, but it is hoped that it will now be apparent that the oldest of this country's industries is increasing its use of modern instruments and it may well be that its economic future will depend upon a very large application of instrumentation and control.

Acknowledgment

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PRECISION AT PULLINS

Introduction

PRODUCTS which require a high degree of precision in their manufacture yet must be sold at competitive prices require very special manufacturing techniques and careful production planning. And when such products include synchros, precision servocomponents, gyro instruments and equipment, cameras for target aircraft, cavity resonators, and the like, the necessity for precision methods will be apparent. The problem of the two opposing factors, price and precision, has been solved at the Brentford Works of R. B. Pullin & Co. Ltd.

The Phoenix Works, Brentford, comprises a total floor area of over 165,000 sq. ft. including a new 70,000 sq. ft. multi-storey fully air-conditioned factory block, and its 60 ft high illuminated clock tower is a well-known landmark on the Brentford end of the Great West Road.

It is proposed in the following description to give an account of some of the many departments and their activities.

Behind the fronting office block, in single storey buildings and adjacent to one another, are the Sales, Accounts, Planning, Estimating, Engineering, Material Control, and Costing Departments. Beyond this is the large main Machine Shop fully equipped with the latest machine tools for the machining of all component parts of the company's products. Close by is the Sheet Metal Shop where an important piece of equipment is the Wiedemann turret punch press. A Welding Shop and Spray Shop with associated oven equipment are adjacent.

The main Assembly Shops are impressive in the range of products they turn out. This includes aircraft instruments and equipment, instrument motors and precision mechanical switching units, gyroscopic navigational

Fig. 1. *Main machine shop*

equipment for land, air and sea and for gunnery control, target cameras, specialised electrical and electronic equipment for Services and Industry.

Nearby, designed to provide conditions as near ideal as humanly possible for the assembly of gyroscopic and other precision instruments is a dust-free assembly and test building fully air-conditioned, pressure controlled and fitted with air-locks. Nylon coats are worn by all operatives and provided for visitors to avoid the risk of dust and lint from clothing.

Proceeding from the main Assembly Shops one comes to the main Test Room fully equipped for practically every kind of test. Here the Pullin aircraft turn and slip indicators are calibrated and finally tested before leaving the works for eventual installation in the Comet, Britannia, Hunter, etc.

New Building

Towering over the works is Pullin's new 70,000 sq. ft. multi-storey, air-conditioned factory block for highly specialised electrical and electro-mechanical precision instruments including the Pullin and Pullin-Kearfott synchros and servocomponents. This building is air-conditioned by circulation ducts within a specially designed reinforced concrete hollow column—a system probably unique in this country and elsewhere. A system of "graded" artificial lighting ensures even illumination under varying conditions.

Grouped in the basement floor are departments engaged in the earlier stages of synchro and servomotor production. For example, one shop has a battery of gear cutting machines for high precision gear cutting. Another shop has machinery for machining synchro and motor parts. Here synchro cylindrical housings may be seen being produced to very fine limits from solid stainless steel rod by automatic machining. The shops are well equipped with measuring tools and gauges, including a number of pneumatic comparators. Here is also a mechanical inspection bay where all components for inspection are received in specially designed plastic transit boxes affording component protection and cleanliness with ease of handling.

Synchro Lamination Production and Treatment

Stator and rotor lamination production for the exacting electrical performance requirements demands considerable care as one can see from the precautions taken in all stages of the work. The laminations are stamped from strip material by a Schuler press and are then cleaned by up to as many as seven baths in cleaning fluid, tap water rinsing, electrolytic cleaning with hot and cold water rinsing. After cleaning, the laminations are annealed in an ammonia cracker unit and temperature controlled furnace. The cracker unit is switched to start up at, say, 4 a.m. so as to be ready for operation by the time the normal working day starts. The furnace tube into which the laminations are placed is first purged with nitrogen for half an hour and then the cracker unit is connected. Annealing proceeds at 1010°C for two hours after which the plant is switched off and allowed to cool to 560°C. Insulating the laminations is the next operation and this takes place in a chamber through which steam is circulated at 560°C.

Stator Assembly

Stator laminations, after annealing and insulating, then go to the Assembly Department where they are measured, weighed and batched. Each lamination from the press has a small nick in the outside edge to indicate the grain direction. This reference nick allows a stator stack to be built up with the metal grain evenly spread for minimum iron losses. After build-up the stator stack is treated with Araldite so that after baking the stack is a solid integrated unit.

The stators are then routed to the Coil Insertion Department where coil sets are skilfully inserted in the stacks by highly trained women operatives. The wound stators are tested for continuity and insulation and then sent to Assembly for final assembly. First the end turns of the coils are formed to shape, then the stator is inserted in its housing and the housing end cap spun on and connections to connection pins made. After this, the inside of the completely housed stator is cast solid in Araldite, cured and then passed to the Machine Shop for straight through boring of bearing housings and stator, thus ensuring precision concentricity of rotor with stator.

Squirrel-cage Rotor Casting

Rotor units for induction type servomotors have their aluminium conductors cast into the rotor lamination stack by a special casting process whereby the rotor is placed inside a mould and the aluminium poured in to fill the lamination slots. After casting, the surplus aluminium is removed and the rotor heated with Araldite and baked.

Fig. 2. *Schuler high-speed press*

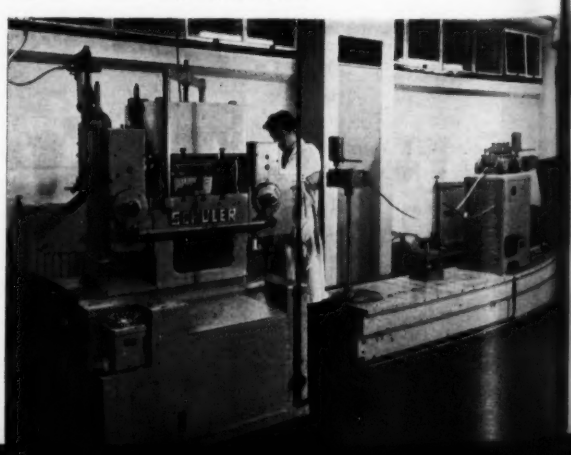


Fig. 3. *Lamination assembly*

Fig. 4. *Synchro testing*

Winding Shop

R. B. Pullin's main Winding Shop is on the first floor of the new building and here practically all the company's wound component requirement is wound and tested. Synchro and servomotor coils are wound in another department. Here the armatures of motors and gyroscopes are dynamically balanced by a machine which indicates on a meter the degree of unbalance when the armature is rotated at speed. Every armature is checked for balance and adjusted where necessary.

Testing Procedures

To ensure maximum performance and to meet the exacting requirements of Grade 1 components all synchro and servomotor ball bearings are first cleaned, then lubricated, and given a frictional torque test.

Testing procedures for Pullin-Kearfott synchros, motors and motor generators as detailed below indicate the thoroughness of the testing programme.

Common Tests

(1) End play
(2) Radial play
(3) High potential flash
(4) Insulation

Individual Tests

Synchros

(1) Shaft run-out
(2) Voltage
(3) Frequency
(4) D.C. resistance
(5) Stiction torque
(6) Current and power
(7) Transformation ratio
(8) Maximum electrical error (a curve is drawn of error in minutes against degrees rotation)

Servomotors

(1) Direction of rotation (reference to second phase leading)
(2) Slot effect
(3) No load speed
(4) Stalling torque
(5) Power input to the two phases
(6) Noise

Motor Generators

(1) Direction of rotation
(2) Slot effect
(3) No load speed
(4) Stalling volts and power for the motor
(5) Generator excitation
(6) Output at rest
(7) Transformation ratio
(8) Stalling torque
(9) Polarity
(10) Output in volts per 1,000 r.p.m.
(11) D.C. resistance for both motor and generator

Development and Research

The whole of the third floor of the new building (17,000 sq. ft.) is given over to development and research which is divided into a number of specialised sections together with a Systems Group. Two of the main sections cover electronic and electro-mechanical work, while purely mechanical design is undertaken in the drawing office. A Materials Laboratory and a Technical Library serve the departments. Also supporting Development is a fully-equipped Development Workshop for experimental and prototype apparatus.

BOOK REVIEW

Flow Measurement and Control

Coxon-Heywood and Co. Ltd. 55/-. 312 *pages,* 246 *illustrations.*

This book forms one of a series "Physical Processes in the Chemical Industry" under the general editorship of Professor J. C. Robb and Dr.W. F. Coxon. To a large extent the theory of the subject has been avoided and the problems of flow measurement are discussed in terms of its practical importance. Reference is made to the basic considerations, particularly of flow measurement by use of differential pressure, and an explanation is given of the various terms used by the flow engineer. Descriptions of details of the various types of fluid meter are provided and reference made to the practical formulae used in British Standard 1042 : 1943. Various types of primary elements such as orifice plates, Venturi tubes, etc., are covered including open channel meters. The remainder of the book is largely of a practical nature, considerable space being given to the location of pressure difference devices and typical instruments used such as mechanical and electrical flow meters and automatic regulators of the pneumatic, hydraulic and electronic type. The importance of flow measurement and control to automatic process control is discussed by reference to flow controllers and transmitters whilst a flow diagram of a hypothetical plant and its instrumentation is discussed in detail. Reference is also made to flow measurement in relation to automatic boiler control.

A PORTABLE AUTOMATIC CABLE TESTER

By A. DOIG*

General

IN many light current applications of multi-core cables high installation reliability is only achieved by periodic preventive maintenance, together with rapid fault-finding techniques. The optimum type of instrument for cable testing under such field conditions should be fully portable, automatic in operation and require minimum skills on the part of the operator. Such an instrument is described in this article.

The de Havilland automatic cable tester is easily portable, weighing only 19 lb, and is independent of external power supplies for its operation. Power is provided by a 24 volt, 4 ampere-hour battery which has an unspillable electrolyte. Sixteen hours of normal operation is obtained between battery charges, and charging can be accomplished in four hours. A 250 volt supply to the trigger tubes and neon indicators, a high impedance voltage source for insulation testing and a current source for continuity testing are provided by a transistor converter. The outlet capacity of the unit is limited to 25 cores, since this is the maximum number used in the majority of light current connectors. It is emphasised, however, that the design of the control unit and its accessories does not preclude the testing of larger numbers of outlets in a cable; indeed, this possibility has been taken into account (see Accessories).

It will be obvious that continuity can be measured only if access is possible to both ends of the cable and, in the case of a number of long or inaccessible cables, the overall testing time can be reduced if two operators are employed and a simple form of inter-communication between them is provided. Hence, a small two-way amplifier is fitted in the tester control unit, which provides communication between the operators via the cable under test. Standard Services or Civil pattern headsets may be used.

Circuit Description

The control unit comprises three main sub-assemblies:—

(i) Sequencing switch; associated logic relay circuits; operating push-buttons; indicating neons and outlet connector. (Fig. 1.)

(ii) Printed circuit board consisting of timing circuit; current monitoring and fault trigger circuits; a.c.-d.c. converter and inter-communication amplifiers. (Fig. 2.)

(iii) Power supply unit containing storage battery, fuses and charging sockets.

Sub-assemblies (i) and (ii) are housed in the upper portion of the plastic case while sub-assembly (iii) is in the lower portion. A gas-tight seal separates the two.

(*i*) *Sequencing Circuits*

A continuity test is initiated by operating the "Continuity" push-button: relay C/5 will thus be energised and will lock up to one of its own contacts, whilst further contacts complete the battery circuit to the d.c. converter, lock out the insulation start push-button switch, select a timer period of 5 pulses per second and complete the h.t. supply to the "Continuity" indicator. Contact C_1 connects the low source impedance test current to the wiper of bank 5 of the sequencing switch. At rest this wiper connects this test current to the first, or normal, bank outlet and hence via the output connector and the coupling unit to the first core in the test cable; the loop is closed by the termination unit at the remote end of the cable and the other cores of the cable. At the end of the first timer period of 120-140 m sec, relay TM/3 (Fig. 2) will be energised for 60 msec, and contacts TM_1 complete the battery circuit to the Ledex solenoid which moves the selecting switch wiper in bank 5 to the second outlet, the test current thus flowing through the second core in the test cable. This sequence continues until the wiper of bank 3 reaches the 17th contact when relay A/5 will be energised. Contacts A_1' transfer the test current from the wiper of bank 5 to the wiper of bank 6 and the sequencing switch proceeds on its second revolution, until all cores in the cable have been tested.

When the wiper of bank 4 rests on the 10th contact a circuit is made to relay R/4 via the link on the coupling unit. Relay R/4 locks up via the homing bank wiper and its contacts R_2 break the hold circuit of C/5, thus disconnecting the supply to the d.c. converter and extinguishing the "Continuity" indicator, whilst contacts R_1 complete a circuit to the Ledex solenoid via the homing bank and its interrupter contacts. The sequencing switch will then self-drive to its normal contact (i.e., Outlet 1). The control unit is now ready to start the next test sequence. A "Reset" push-button is provided to return the control unit to the rest condition before all cores are checked, thus expediting a cable test in the event of a fault appearing early in the test sequence by enabling the test to be stopped if desired. In general, when there are n cores in a cable, the link

* de Havilland Propellers Ltd.

on the appropriate coupler allows relay R/4 to be energised when the wiper of either bank 3 or 4 (depending on whether the sequencing switch is on its first or second revolution) rests on outlet n + 1, thereby resetting the control unit when all cores in the test cable have been checked.

In the event of a fault, the fail relay F/5 (Fig. 2) will be energised, and contacts on this relay inhibit the sequence switch operating timer and strike the fail indicating neon tube appropriate to the test bank in use. The neon tube illuminates a transparent digit on a film strip, which is viewed through an aperture in the top of the case. This digit corresponds to the faulty core in the test cable. Subsequent operating of the "Continuity" button energises the Ledex solenoid and hence steps the sequencing switch to the succeeding outlet, thus releasing relay F/5; unless, of course, a fault is also present on the next core. Assuming that this is not so, the sequencing switch continues to be pulsed by the timer until all the cores have been tested. Operation of the system is similar for insulation testing with the exception that when the "Insulation" push-button is operated, relay I/4 is energised, and its contacts select one of three pre-selected time periods (either 2, 4 or 10 pulses per minute), strike the "Insulation" neon indicator, and select the 500 volts supply from the high impedance output of the converter. Should a lower order of insulation test voltage be required, a simple modification may be effected.

The outlet connector is an AN 3106 A/28-158, of which the first 25 outlets carry the test voltages, and outlets 26 to 33 are the "end of test" logic wires; outlet 34 is the −12 volt line (amplifier supply) and outlet 35 the intercommunication amplifier supply rail.

(ii) Printed Circuit

Two OC 30 medium power transistors in a self-oscillating converter using a toroidal transformer as coupling element produce a 960 c/s square wave. A pulse circuit consisting of an OC 77 and a small toroidal transformer ensures reliable starting of the converter on full load (i.e., when a fail condition exists on the first outlet). The oscillator transformer has two secondaries, one supplying the h.t. voltage full-wave rectifier, whilst the other is connected to the primary of the test voltage output transformer. On continuity testing the primary of the trigger transformer is connected across the output transformer and the trigger transformer secondary voltage is rectified and applied between trigger and cathode of a Z803U cold cathode trigger tube; thus, as the load current decreases (i.e., the conductivity of the test core decreases), the voltage across the trigger transformer secondary increases until the trigger breakdown potential is reached, at which point the tube ionises and the fail relay F/5 is energised. On insulation testing, however, contacts on relay I/5 switch a precision resistor in series with the test voltage output transformer primary, and the rectified voltage across the resistor is applied to the trigger electrode of the Z803U—hence, as the load current increases (i.e., leakage resistance of the core decreases), this voltage across the resistor increases until the trigger

Fig. 1. Selector circuits

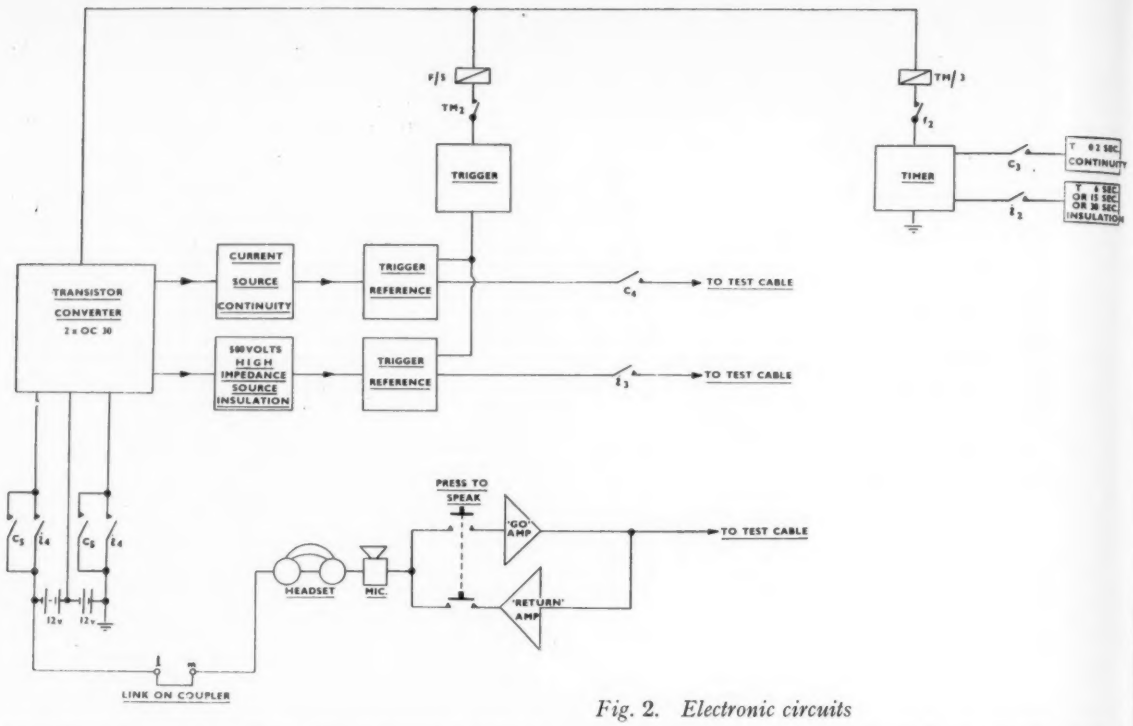


Fig. 2. Electronic circuits

breakdown voltage is reached. The fail level is defined on continuity by the value of a precision resistor in series with the trigger transformer primary and will be pre-set prior to despatch from 5 ohms upwards.* This value may, in fact, be reduced to 1 ohm if certain conditions are placed upon the use of the inter-communication facility (see Accessories). On insulation testing the fail threshold is defined by the value of the source precision resistor and can be pre-set from 2·5 megohms downwards. The trigger breakdown potential of the type Z803U tube is controlled to within ±2%, and the measurement accuracy of the unit is better than ±10% in the worst case. It should be noted that on continuity testing the 960 c/s square wave at 120 milliamp on short circuit is the testing current: hence incipient dry joints or broken strands can be indicated.

The sequence switch operating timer employs another Z803U trigger tube, the trigger breakdown voltage being developed across a capacitor charged from the h.t. rail through a high stability resistor chain. Values of capacitance and resistance are arranged to provide a charging time constant of 120 to 140 m sec on continuity testing and either 6, 15 or 30 seconds ±10% on insulation testing. When the tube is ionised, relay TM/3 in its anode circuit will be energised, and break contacts on TM/3 disconnect the h.t. rail from the tube, which is extinguished. However, the charge on a 16 μF capacitor maintains the relay TM/3 energised for a further 60 m sec ±10%, this is the sequence switch drive pulse.

A simple two-way amplifier employing two OC75 transistors in common emitter mode provides 12 dB (50 ohm) gain with 3 dB points at 400 and 1,600 c/s. An inter-communication facility is available from the remote end of the cable under test, and is obtained in the reverse direction by operation of the "Speech" push-button switch on the control unit.

(*iii*) *Power Supply Unit*

The power supply unit contains a 24 volt Varley battery Type VPT11/4T of 4 ampere-hour capacity. The 12 volt and 24 volt lines are fused at 3 amp (see Accessories).

Accessories

Extension Cable. A 6 ft extension cable permits connectors in confined spaces to be mated to the tester. This cable consists of 35 wires terminating in an AN3102A/28-15P connector for mating with the control unit outlet connector, and an AN3101A/28-15S to mate with the coupling units.

Couplers. The couplers have one connector Type AN3102A/28-15P on one end to mate with the control unit, or extension cable. The connector on the other end is specified by the user. Test outlets are wired between the AN connector and the users' specified connector (one to one), whilst the "end of test" point is defined by a link on the AN connector from outlet 33 to one of the outlets 26 to 32 inclusive, depending on the number of cores in the test cable. A further link between outlets 33 and 34 on the AN connector

* All cable testers will be manufactured with fail limits set at 5 ohms and 1 megohm on continuity and insulation respectively. This is to facilitate inspection and test. However, to meet users' special requirements within the ranges indicated above, the required precision resistors will be substituted and the unit re-checked to users' specifications prior to despatch.

completes the inter-communication amplifier h.t. circuit, ensuring contact between the operators *before* testing commences. In order to cater for the type of plug or socket, in which the connector orientation is varied, the coupler outlets have a rotatable insert which may be aligned to the termination of the test cable.

Switched Couplers. In cases where more than 25 cores have to be tested a switched coupler unit can be supplied. The first 25 cores in the cable are checked in the normal way: a switch on the coupler unit is then moved to the second position and when the continuity or insulation start button is operated, the second 25 cores in the cable are checked; this can be repeated until all cores in the cable have been checked.

Terminators. Terminators consist of two similar connectors specified by the user to suit his cable terminations. One connector has a transformer primary ($R \leq 5$ ohms) connected between outlets 1 and 2 with all other outlets connected together and to outlet 2—this is used for continuity testing. The connector on the other end of the unit, for insulation testing, has all outlets open-circuited to d.c. but outlets 1 and 2 are connected to the inter-communication transformer via 750 volts working low leakage capacitors. The secondary of the transformer is connected to the microphone/telephone headset socket situated on the side of the terminating unit. If the fail threshold on continuity is set at less than 5 ohms a spring-loaded switch is fitted to the terminator which will short circuit the inter-communication transformer primary before testing.

Mains Power Supply and Charging Unit. A battery charging unit is available and consists of a mains rectifier with a nominal 24 volt output. This charging unit and the alternative mains power supply for the cable tester are interchangeable. When the charging unit top plate is connected to the output socket of the mains unit, a microswitch is operated which connects a charging current meter and current limiting resistor into the mains power unit output lead. Thus a single unit may be used either as a mains power unit or as a battery charging unit. This combined unit operates from 200/250 volt 50/60 c/s mains supply.

Coupler and Terminator Storage Case. A storage case is available for terminations and couplers. A single unit will contain 12 couplers or terminators but the storage units may be stacked to provide storage for any number of couplers.

Acknowledgments

The author wishes to acknowledge his indebtedness to the Chief Electronic Engineer of de Havilland Propellers Limited for permission to publish this article, and to Mr. R. V. Watson, of the Company, for his encouragement and advice during the development of the instrument.

MULLARD TECHNICAL PAPERS

At a recent private exhibition of valves and tubes for industrial control and instrumentation, the following technical papers were presented by members of Mullard's staff.

1. Cadmium sulphide photoconductive cells.
2. Design and manufacturing techniques which contribute to valve reliability.
3. Decade counting tubes.
4. Thyratrons, some aspects of their satisfactory application to industrial control.

Three of these papers are summarised briefly.

Cadmium Sulphide Photoconductive Cells

Cadmium sulphide cells are extremely responsive to visible and near infra-red radiation. The spectral response varies between different manufactures, but generally the range covered is 0·4 to 0·9 microns. The overall sensitivity is several orders higher than that of photo-emissive cells. Under comparable conditions a photo-emissive cell will pass or produce a few micro-amperes when a cadmium sulphide cell will pass several milliamperes, enough to operate a cheap d.c. relay direct.

Response time is one of the characteristics that limits applications at the moment. The response picture is also complicated by an apparent dark storage effect. If the cell is stored in the dark its sensitivity tends to increase for a few days when it becomes steady. When it is operated the sensitivity returns to its normal level in a time dependent to some extent on the light level. When light and/or voltage is applied to the cell, the current rises to a maximum in about two seconds and then decreases by an amount dependent on the previous "off" condition and time.

There seems to be an upper temperature limit for satisfactory operation in the region of 70°C. Below this temperature the power dissipation in the cell has little, if any, effect on life, as long as the upper power rating is not exceeded.

At the present it is difficult to make any recommendations for using the cell as a really accurate measuring device, except to say that everything possible should be done to keep the cell operating under constant conditions.

Decade Counting Tubes

Multi electrode gas-filled stepping tubes have for many years been employed in a wide variety of applications: batching, nuclear particle counters, frequency division, resistance welding, time marker pips, etc. However, very little has been written on the parameters of these tubes. As a result, on occasions limiting characteristics have been exceeded resulting in unsatisfactory operation. This paper gives further information on this subject and refers directly to the Mullard counting tube Z303C (CV2271) and the selector tube Z502S (CV2325).

Thyratrons, Some Aspects of their Satisfactory Application to Industrial Control

The thyratron is widely used for the control of the power input to electrical apparatus in the low and medium power range, i.e., up to approximately 25 kVA. Thyratrons can be used as controlled rectifiers so that a d.c. load is operated and controlled from an a.c. supply, or the thyratrons can be connected in inverse parallel so that a.c. loads can have their input power controlled. Typical uses for thyratrons as controlled rectifiers are in stabilised power supplies, motor control circuits and some lighting control circuits. D.c. supplies have been built having a voltage output which varies by only 0·1 V for all load and mains variations. These supplies have been made for output currents of up to 36 amp and voltages up to 500 V.

Two thyratrons in a very simple and inexpensive back-to-back circuit can be used as a switch and under certain conditions provide far longer life and better control than any mechanical switch. A typical example of this is in spot welding control circuits. Another type of duty in which thyratrons are used as switches is for the conversion of direct current to alternating current. In the inverter the centre tap of a suitable transformer is connected to one pole of a d.c. supply through a choke while the two outer connections of the transformer are connected alternately to the other pole of the d.c. by two thyratrons.

Thyratrons are generally grouped into two types, mercury thyratrons and xenon thyratrons. The former have the disadvantage of long warming up time and a restricted temperature range in which they will operate. The xenon inside thyratrons tends to disappear if the valve is subjected to certain adverse operating conditions. However, if precautions are taken, xenon valves are found to have very long lives without the disadvantages inherent in mercury thyratrons.

NEW PARAMETRIC AMPLIFIER

THE Zenith Radio Corporation recently announced the development of a fast wave parametric amplifier of the vacuum tube variety for use in ultra high frequency and microwave radio receivers. Typical performance data for the new amplifier are a noise figure about 1 dB and a gain up to 30 dB. The tube is based on new concepts that involve the removal of noise from a fast wave on a stream of electrons which carries the signal, and the parametric amplification of that wave. Like most radio tubes, the Zenith unit and its auxiliary components form "a small package". It requires no cumbersome refrigeration equipment and can be used in connection with existing u.h.f. and microwave receivers.

The amplifier will greatly extend the effective range of military defence radar as well as that of missile and earth satellite tracking systems and it can also be used in equipment for long-range communications.

The amplifier is said to be completely unilateral and unconditionally stable. The new development utilises an idea in which a certain mode of motion on an electron beam (the so-called fast wave) permits interchange of input signal and beam noise in a coupler. In conventional amplifiers where all external power is supplied in the form of direct current, the fast wave cannot be used. In the new Zenith amplifier, the fast wave is amplified with the help of externally applied alternating fields, a method which is one form of what has recently come to be called parametric amplification.

An electron gun in the tube, which is similar to the gun used in picture tubes, generates an electron beam of about 35 μA which drifts at very low velocity, corresponding to only 6 volts, along the lines of a 200 gauss magnetic field. Input and output couplers are tuned to the centre of the signal frequency band, about 560 Mc/s. The electron beam enters the input coupler with a certain amount of random motion. The fast wave component of this motion is given up to the input coupler and transformed into heat in the resistive portion of the signal source. At the same time, the beam absorbs signal energy and carries it in the form of a fast wave, thus interchanging beam noise and input signal. The spiralling electron motion which carries the signal is amplified during passage through the quadrupole electrode, a structure that resembles the stator of a four-pole generator; it produces a highly non-homogeneous transverse electric field of four-fold symmetry. The quadrupole is connected to the "pump" which supplies about 10 milliwatts at about 1120 Mc/s.

One component of the alternating non-homogeneous field pattern in the quadrupole appears to revolve in synchronism with the spiralling electrons; this causes the radius of their orbits to increase or decrease exponentially, depending upon their phase at the instant of entry. When the two processes are averaged exponential growth always outweighs exponential decay and gain results.

Regardless of how the signal frequency is altered, the individual electrons always spiral through the quadrupole at a rate of rotation determined by the magnetic field. As a result, the signal frequency does not affect the amplifying process and the band-width is limited only by the input and output couplers. The gain for which the pump power is adjusted has no effect on the band-width.

The tube is only 4 in. in length and is relatively simple to produce and operate. Work is now under way on several versions of the tube for different fields of application.

ANODISED ALUMINIUM WINDINGS

COMMERCIAL production of continuously anodised aluminium foil and strip for electrical windings, particularly in magnets and transformers, is under way at Tyne Chemical Co. Ltd., South Shields.

An indication of the extent of this achievement is that they are currently producing anodised strip material from aluminium foil, of thickness 0·002 in. to 0·06 in., in widths of a maximum of 12 in. continuously anodised in lengths of a 1,000 yards. The breakdown voltage figures reached under this new technique are the highest yet obtained in this field.

For example, with some anodised material 3 in. wide × 0·0035 in. thick, the anodic coating of 6·4 microns at the centre, increasing to between 7·3 and 9·4 microns at the edges, resulted in breakdown voltage figures of the order of:—

Centre 375, near the edge (about 1 or 2 mm from the edge) 400 and directly on edge 480.

Another example of anodised material 2·375 in. wide × 0·018 in. thick, the anodic coating of 7 microns at the centre increasing to between 10·8 and 13·8 microns at the edges resulted in breakdown voltage figures of the order of:—

Centre 305, near the edge (about 1 or 2 mm from the edge) 450 and directly on the edge 475.

Close examination over a considerable length located no points of short circuit and there was adequate film thickness with a reserve to withstand maltreatment.

Technical Advantages of Aluminium

Flat windings of foil or strip with equivalent conductivity of a copper wire winding can be equal in volume, and in some cases smaller, notwithstanding the fact that the conductivity of aluminium in the 99% to 99·5% purity range is approximately 59% to 61% that of copper. Aluminium is also much lighter and in this form provides an improved heat transfer rate across the coil eliminating the hot spots encountered in circular cross-section windings. Adjacent layers have only turn-to-turn voltage difference eliminating the need for thick layer insulation commonly associated with round wire windings.

Anodised foil or strip can safely withstand considerable periods of over-load allowing designs to be of normal rating without providing for large safety factors. This would lead to a general reduction in the overall size.

Improved production methods can bring economic advantages. The simplicity of winding and the prospect of multi-winding machinery could step up production far more rapidly than with the traversing complications of conventional machinery. Aluminium strip and foil are basically much cheaper than their copper counterpart and attendant labour economies are obvious (tapping and leading out coil ends becomes a much simpler operation).

Anodic Film

The building up of an oxide film to enable aluminium foil or strip to be used as a conductor "sheathed" with its own insulation is the basis of the method of production.

The electro-chemical process, anodising, thickens the natural oxide layer from the "inside" of the film by passing a current in an acid electrolyte using the aluminium as the anode. Sulphuric, chromic, oxalic, boric and phosphoric acids are used in various processes to give the required results.

Consistent thickness, density, hardness and absence of pores, together with flexibility of the film are all features which must be given careful consideration. Corrosive resistance of the anodic film varies with the alloys on which it is being produced. It is greatest on commercially pure aluminium and least on alloys containing large amounts of copper or zinc.

The anodising process does not alter the mechanical properties of the aluminium but as an indication of the toughness of the film, the basic metal, when heated above its melting point, will melt but still be retained in the anodic film.

The breakdown voltage depends on the alloys, film thickness, texture and moisture content but is not affected by increases in temperature up to 400°C.

Temperature Resistance

The vulnerability of insulating materials based on organic compounds at high temperatures has been a strong influence on design within the electrical industry. Even the more modern silicone resins are not free from this vulnerability. Anodised foil or strip may be allowed to heat far beyond any temperature permissible in windings being used (possible exceptions are windings employing asbestos sleevings which are bulky, costly and cumbersome). Design margins on the grounds of temperature can be largely eliminated using anodised material.

Production Limitations

The present production range of Tyne Chemical Co. is limited to 0·002 in. to 0·06 in. thick and up to 12 in. wide, but these limits depend on mechanical considerations and may well be extended in the future. The material is anodised uniform on both faces, thicker at the edges, in finished widths. Foil and strip are required to have a sound edge condition free from the edge weakness of slitting burrs.

The snags of "brittleness of film", "abrasion resistance and flexibility" (there is no limit to the radius over which it can be bent) have been overcome. The special precautions taken by the Tyne Chemical Co. against low breakdown resistance of the strip at the edges will reassure designers who will find the edge is the best part of the insulator.

ANALOGUE COMPUTER FOR ESTIMATING FIRE ENDURANCE

An electronic analogue device that solves transient heat flow problems has been constructed. It is based on the similarity between current flow in electrical circuits and conductive heat flow in thermal circuits. In particular, the instrument can estimate the fire endurance of structural building elements subjected to the temperature-time exposure of standard fire tests.

A SPECIAL-PURPOSE analogue computer[1] that analyses heat flow in building materials has been developed by A. F. Robertson and D. Gross, of the National Bureau of Standards. This desk-sized instrument makes possible rapid estimates of the transient heat flow within building materials or constructions. Although its use is not likely to eliminate the need for full-scale fire tests, it is expected to be useful in reducing their number.

Fire resistance tests are often performed on portions of buildings to determine how well the construction will withstand the effects of fire. However, the expense of building the test specimen and the long time required to perform the test make desirable some high-speed method for estimating fire endurance of structures.

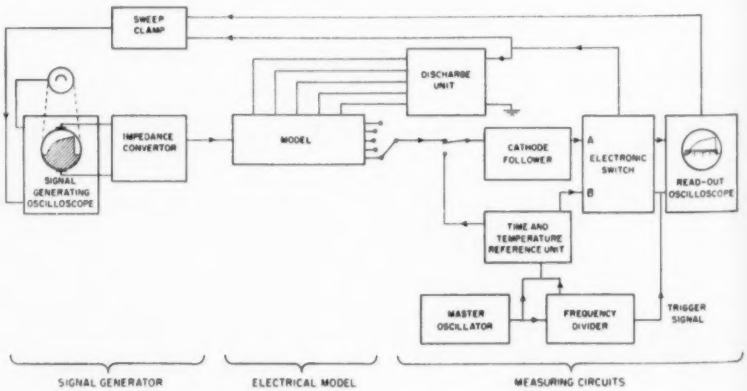
The present device provides such a method by using a direct analogy between thermal and electrical circuits. This type of analogy permits considerable flexibility in solving heat-flow problems. At the same time it simplifies the coding of problems and eliminates the large assembly of electronic mathematical-operator units which conventional computers require to solve the problem of heat transfer by conduction.

The instrument is of the "fast time" type, in which a problem is solved repetitively at a speed much higher than can be obtained with an actual test specimen. Essentially, it applies voltage signals corresponding to the prescribed temperature-time conditions of a standard fire test to an electrical model representing the material under study, and then displays on a cathode ray tube the resultant temperature-time curve at any of several points within the material. The equipment consists of a signal generating unit, means for applying the signal to an electrical network, and circuitry to measure the transient voltages developed within the model. The time ratio between the electrical operation and the thermal process is of the order of 10^{-6}. Such high speed requires cathode ray tube presentation for read-out of the repetitively solved problem.

A custom-made electrical model is prepared for each thermal problem to be simulated. A plug-in unit provides 20 network elements and discharge points. A series of resistors represents a lumped approximation to the continuous thermal resistance of the prototype, and a group of capacitors shunting these resistors to ground represents a lumped approximation to its heat capacity.

Signal Generator

The signal generator, a photoformer unit, was selected for flexibility in choice of possible waveforms and the ease with which they can be interchanged. It is basically an oscilloscope with an opaque mask covering a portion of the cathode ray tube face. The shape of the mask corresponds to the shape of the desired input waveform. A phototube with appropriate amplifier is arranged to view the face of the cathode ray tube. The amplified output of the phototube is applied to the vertical deflection plates of the cathode ray tube in such a way that when the spot is "seen" by the phototube it is deflected so as to be partially hidden by the mask. The combination of a feedback in the vertical plate circuit, and a relaxation timing sweep on the horizontal plates forces the spot to follow the mask outline on the cathode ray tube screen. Since the voltage applied to the deflection plates is proportional to the



Block diagram of the special-purpose analogue computer for analysing heat flow in building materials

displacement of the spot on the screen, a voltage/time signal, controlled by the shape of the mask, can be taken from the plates.

The signal generating oscilloscope permits reasonable linearity between mask shape and output signal. Its tube has a short-persistence Type P-15 phosphor. The short decay time of this phosphor, down 90% in 2·8 microseconds, is necessary to permit close following of the mask shape during rapid transients. For maximum response, the photomultiplier tube associated with the oscilloscope was selected to have a spectral sensitivity closely matching the cathode ray tube phosphor. A darkened hood shields the photomultiplier from stray external illumination.

In using a signal generator of this type, it is essential that the spot remains on the tube screen even during periods when signals are not being generated. To permit this, the generating oscilloscope was modified by insertion of a clamp circuit in the horizontal deflection circuit to prevent the spot from leaving the right-hand edge of the screen. The clamp circuit does not abruptly limit spot deflection at one position, but instead greatly reduces the deflection sensitivity when the spot approaches the edge of the screen. This type of operation is easy to achieve and helps to prevent "burning" the phosphor of the cathode ray tube screen.

Impedance Converter

An impedance converter combines the balanced but out-of-phase voltages applied to the deflecting plates of the generating oscilloscope into a single-phase low-impedance output signal with ground as a reference level. A pentode is used here in the unity-gain phase-inverter circuit and a twin triode in the averaging circuit. This works well as a substitute for a true addition circuit because both signals are of the same order of magnitude.

Sweep Clamp

The horizontal timing sweep that forms the input signal is obtained from an internal connection to the sweep generating circuit of the viewing oscilloscope. The sweep clamp provides a means for rejecting every alternate sweep cycle and thus generating an input signal only when it is necessary to apply one to the model.

Cathode Follower

A cathode follower is used as a high-impedance probe feeding a wide band impedance converter. This circuit has the desirable feature of permitting high-impedance operation with large input signals. The potential divider between plate and cathode of the first stage of the twin triode serves as a variable plate supply source for the 6AK5 used as cathode follower input stage. In this manner large voltage signals can be followed while at the same time limiting the potential drop across the input tube. Frequency response is very nearly linear up to 25 kc/s. The output of this circuit is mixed with the time and calibration signal by the electronic switch.

Time Base Generating Unit

The time reference standard for the unit is a variable-frequency square-wave oscillator. The output of this unit is fed to the temperature and time reference unit and to the frequency divider. The former consists of differentiating, rectifying, and mixing circuits.

The frequency divider circuit uses one each of scale-of-ten and scale-of-twelve glow counter tubes in series. The first tube permits accentuation of each tenth timing mark while the second permits generation of a synchronising signal as a submultiple of the scale of ten count. The outputs from each of the twelve cathodes of this tube are separately available so that considerable flexibility is possible in generating a time signal appropriate to the input signal. The output synchronises the time sweep of the viewing oscilloscope and the switching of the electronic switch. An internal connection to the electronic switch provides a square-wave output in synchronism with the trigger input signal. This square wave drives both the sweep clamp and the discharge circuit.

Discharge Unit

The discharge circuit is made up of three separate circuits: (1) a twin triode amplifier and phase inverter whose output is split into two signals; (2) a set of discharge triodes for each individual section of the model; and (3) a clamp diode reference level generator. This last unit is necessary to balance out the potential drop across the clamp diodes and thus permit discharge of the network model to the ground reference level. In the original unit of 20 discharge triodes, ten twin-triode tubes were used to permit complete discharge of a 20-section electrical model.

Read-out Oscilloscope

The viewing oscilloscope, on which the problem situation is displayed, is of a type suitable for driven sweep operation from an external trigger signal. This facility, together with the highly linear time sweep source for the signal generator are the only essential requirements of the unit. High linearity of the vertical deflection amplifiers is not essential because of the way in which the different input signals are compared.

Reference

(1) An electrical analog method for transient heat flow analysis. A. F. Robertson and D. Gross, *J. Research N.B.S.*, **61**, Aug., 1958, p. 105.

SYMPOSIUM ON HIGH VACUA

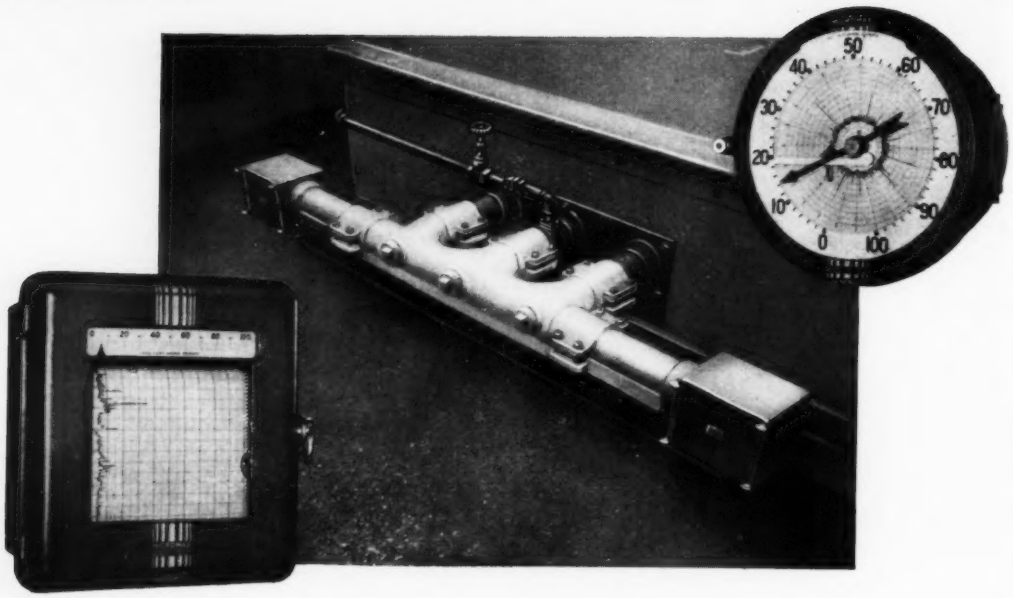
The Institute of Physics is arranging a one-day symposium entitled "Current developments in the production of high vacua" to take place in London on 17th April.

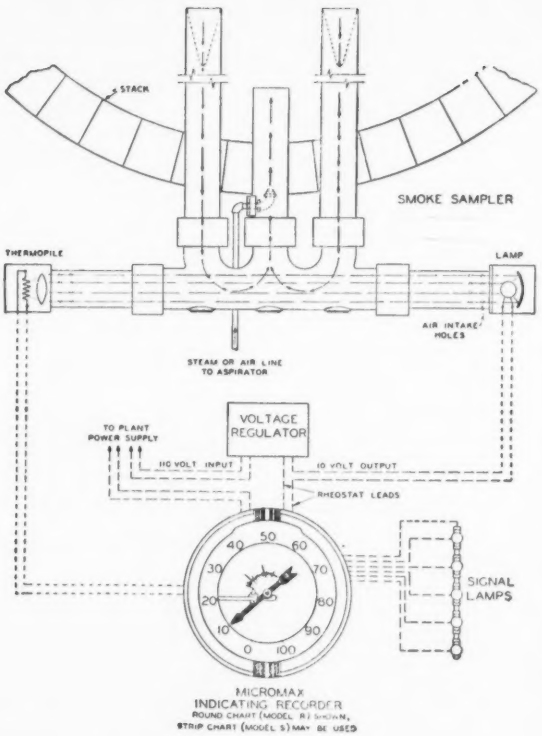
There will be three sessions:—

(a) Chemical and ionic pumping in kinetic vacuum systems.
(b) Problems in the production of high vacua in large equipment.
(c) Analysis of residual gases in kinetic vacuum systems.

The symposium is intended mainly for persons working with high vacua. Abstracts (but not preprints) will be circulated before the symposium, the proceedings of which will not be published in full.

Circle **53** for further information





Smog!

The Leeds Northrup Smoke Density Recorder

Drastic reduction and eventual elimination of the emission of smoke into atmosphere is a vital necessity. It is a menace to health, and economically, a sign of poor combustion and therefore waste. Leeds Northrup Smoke Density Recorder equipment is inserted in one side of the stack only. Smoke is drawn in through the outer arms of the sampling unit and flows out through the central arm clear of lens and thermopile unit. Radiation from the lamp which is fed from a constant voltage unit falls, on the thermopile, the amount of illumination varying according to the density of smoke passing through the sampling unit. Thermopile output—the measure of smoke density — is fed to a potentiometric recorder.

Excess smoke means poor combustion and waste.

Send for a descriptive leaflet to Dept. P.C.

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Smoke Eliminator

An important contribution towards cleaner air, particularly in so far as the smokeless operation of industrial boiler plant is concerned, is being made by a newly-established engineering concern which is now manufacturing under licence smoke eliminators designed and developed by the Fuel Research Station of the Department of Scientific and Industrial Research.

Apart from ensuring that smoke emitted conforms with statutory obligations under the Clean Air Act, the installation of these new eliminators is claimed to effect substantial savings.

Two types are currently available, one for natural draught hand-fired boilers, and the other for similar boilers with forced draught.

The company is also marketing a new smoke density indicator, also developed by the Fuel Research Station of D.S.I.R. which is said to provide a simple, efficient and immediate means of detecting the emission of dark smoke.

Circle **1A** *for further details.*

Transistorised Time and Frequency Measuring Equipment Type TSA53

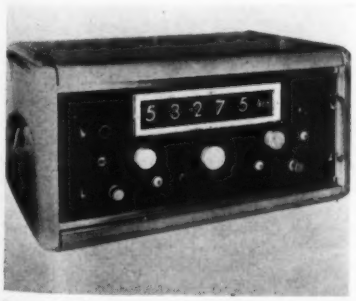
This instrument incorporates a new form of optical digital in-line display. Readings are presented in the form of brightly illuminated one-inch high numerals readable from a distance of thirty feet. The decimal point is correctly placed and the units of measurement are also indicated.

The clear unambiguous method of indication renders the instrument particularly suitable for production use by semi-skilled operators and for any applications where repeated readings have to be taken over long periods.

Specification

Period measurement from 0·00001 c/s to 10 kc/s. Time measurement of any event from 1/10,000th of a second to 11½ days. Frequency measurement up to 100 kc/s. Random pulse counting up to 100 kp.p.s. Self-checking on six frequencies. Accuracy exceeds ±0·005%. Facility for printer operation. Variable display time, ½ to 5 seconds or infinite. 0·1 second, 1 second and 10 seconds sampling times.

Circle **2A** *for further details.*



Transistorised time and frequency measuring equipment

Radyne Silicon Zone Refining Unit

This unit will handle silicon rods varying from 1-2½ cm in diameter and 15-56 cm in length. The principle of operation used is to traverse the coil over the silicon rod whilst the latter is rotated. The plant is complete with all vacuum equipment and control gear and is designed to work in conjunction with either 5, 10 or 15 kW, 450 kc/s, 3-4 Mc/s Radyne r.f. generators.

The work coil is traversed by means of a 4 t.p.i. recirculating ball lead screw, driven by a Servo-Mex Velodyne motor. This motor drives the lead screw via a special gear box incorporating a double Autronic electro-magnetic clutch. Two fixed ratios of 6,000 : 1 and 150 : 1 are provided so that a fast return speed is provided by the switching of the Autronic clutch. Both the forward and reverse speeds are continuously variable. The working stroke is from 0·25 in. per minute (38 cm per hr) to 0·008 in. per minute (1·27 cm per hr) and the fast return stroke from 10 in. (25·4 cm) per minute to ⅛ in. (0·8 cm) per minute. The cycle is completely automatic and includes a dwell timer to allow the zone to be re-started at the beginning of each stroke. The work coil bracket is mounted to a linear ball-race slide to minimise vibration.

Complete vacuum equipment is provided comprising air-ballasted vacuum pump, oil diffusion pump with baffle valve also Pirani vacuum gauge, isolation and air admittance valves, etc.

Circle **3A** *for further details.*

Diode Tester

The tester covers current from 5 amp to 50 microamp, full scale, and can handle from 3 to 1,200 volts, also full scale. Current and voltage are read simultaneously on separate meters.

All semiconductor diodes, including Zener types, can be fully tested as the ranges are operative for both forward and reverse characteristics. A forward/reverse switch reverses the polarity of the output. Thus, a diode, once connected, need not be touched until its complete characteristics have been taken.

A four position range switch controls both the current and voltage to the output terminals and also adjusts the appropriate meter scales, which reduces the chances of damaging either diode or meters. Subsidiary switches allow the voltage scale to be expanded by four times, and the current scale by up to 1,000 times (in three steps: 10, 100 and 1,000). Small lights indicate which range on each meter is in use for any setting of the switches, thereby greatly facilitating meter reading.

The instrument measures 12 in. × 8½ in. × 8 in. overall and requires an a.c. mains input of 200-250 volts at 50 c/s. Total power consumption is dependent upon the range in use, but never exceeds 45 watts.

Circle **4A** *for further details.*

Trolley

F. Piper & Sons Ltd. have taken over the "goodwill" and manufacturing rights of the whole of the "Mobility" range of tubular steel type trucks, trolleys, wheels and castors.

They are introducing a new "Mobility" trolley.

The chassis is made in 1⅛ in. diameter steel tube. Its overall length is 36 in., width 24 in. and height 36 in. It is fitted with two 6 in. roller bearing wheels on a 1 in. axle and two 6 in. ball bearing castors.

"Mobility" tubular steel trolley

The removable trays, which are made of deal, have an inside measurement of 34 in. length by 20 in. wide by 1¾ in. deep. The distance between trays is 20 in. and it will carry a maximum load of 100 lb.

Circle **5A** *for further details.*

Radiation Pyrometer with Photo-cell Detector

A NEW radiation pyrometer, which meets the foundry industry's growing need for closer control of liquid iron/steel temperatures, has just been introduced by Land Pyrometers Ltd. Known as the R.P.18, the new pyrometer will measure the temperature of the metal as it leaves the cupola or holding furnace, with an accuracy comparable to that of an immersion pyrometer.

By using a photo-cell instead of a thermopile, the manufacturers have successfully eliminated the serious effect of metal emissivity on the accuracy of the reading.

Calibration is for the normal emissivity of a liquid metal stream and the small variations encountered in practice have a negligible effect only on the readings.

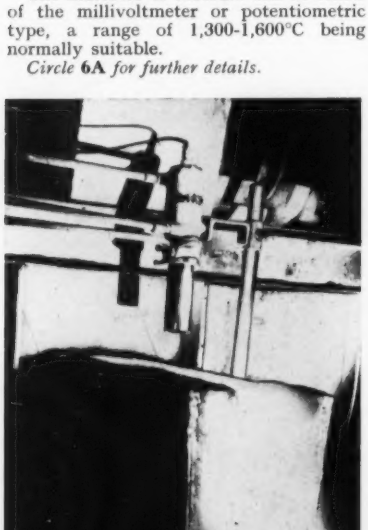
The R.P.18 can be focused on a target as small as one square inch and is, therefore, easily sighted on the metal stream in the slag box. The pyrometer lens is protected by a window of heat-resisting glass, which can easily be cleaned, or replaced, if accidentally splashed with metal.

To avoid damaging the photo-cell, a water jacket is supplied with the new instrument in order to keep its temperature below 40°C. The pyrometer is easily clipped into the jacket with an accurately-reproducible alignment.

Another integral part of the equipment is the air purge unit, which enables an air jet to be blown down the optical path to keep it free from fumes. This also helps to protect the pyrometer window.

The indicator or recorder can be either of the millivoltmeter or potentiometric type, a range of 1,300-1,600°C being normally suitable.

Circle **6A** *for further details.*



Radiation pyrometer with photo-cell detector

"Magloy" magnets

The "Magloy" Range of Permanent Magnets

A WIDE range of cast permanent "Magloy" magnets are now being produced. These magnets, which are made from precipitation-hardened ferro-magnetic alloys, have many applications in the radar, television, electronics, communications and aircraft industries, including certain domestic uses.

"Magloy" materials enable precision cast magnets to be produced to relatively close tolerances. These magnets possess good magnetic resistance to shock and vibration at any frequency; they are stable to within ±0·02%/°C temperature rise up to 500°C; their resistance to external magnetic fields is such that their gap field strength will remain constant in use even after the influx of such external fields.

In addition, die-cast aluminium jackets are provided both for mounting and protection purposes as well as synthetic jackets to provide absolute protection against magnetic damage.

The principal feature of this latest technique is that more efficient designs are practicable, especially in magnets for microwave applications such as magnetrons, klystrons, travelling wave tubes, and a wide range of commercial applications.

Circle **7A** *for further details.*

Mercury Tube Timer Type SAT

TIMER Type SAT is capable of continuously repeating a pre-determined sequence of operations or it can stop after a single complete timing cycle if one of the mercury switches is wired in series with the motor of the timer. This instrument is most suitable for direct switching of highly inductive loads, with the contact arcing occurring inside sealed mercury tubes only.

The timer is driven either by a miniature synchronous motor or by a universal motor for operation on a.c. or d.c. The motor gears are easily exchangeable, giving alternative speeds for the cam shaft which operates tilting mercury tubes. For timing cycles of over 30 seconds duration the mercury tubes are placed on tilting platforms with snap action mechanism, rapidly moving the platform either to 'on' or 'off' position. On faster timing cycles the snap action mechanism is unnecessary, cams directly operating the mercury tube platforms. The timers Type SAT with snap action mechanism are coded SAT/S.

If a mercury tube has to perform a switching action several times during a timing cycle, the operating cams are pre-cut to customers' specification; but if the tube has to operate once only during the timing cycle, continuously adjustable cams are supplied.

The flexible leads from mercury tubes are connected to a terminal block above the timer.

Operating Voltage

Standard voltage supply 200/250 V, 50 c/s, 1 phase a.c. Timers are available also for operation on the following supplies:—110 V, 50 or 60 c/s, 1 phase a.c.; 440 V, 50 c/s, 1 phase a.c.; 6 V, 12 V, 24 V, 110 V and 220 V, d.c. Other voltages on application.

Timing Cycle

The timers Type SAT are available with practically any shaft speed between one revolution in one second and one revolution in 28 days.

Switching Action

Single pole or changeover tilting mercury tubes with switching capacity of 5 amp, 10 amp, 15 amp, 20 amp or 30 amp are fitted as standard. The timer can have any number of cams and mercury tubes but if units with more than 24 cams are required, the timers have two or more timing shafts driven from a common motor.

Mounting and Overall Dimensions

The size of the timer Type SAT depends on the number and rating of mercury tubes and the size of the motor used. A small timer Type SAT with two cams, each operating a 10 amp mercury tube, driven by a synchronous motor has the overall dimensions of 5 in. × 7 in. × 6 in. The timer must be mounted always in a truly horizontal position.

Application

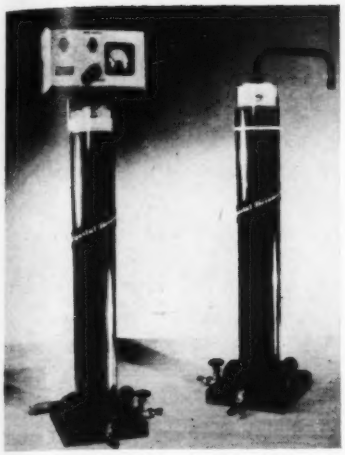
Timers Type SAT are suitable for frequent switching of highly inductive loads, for example, the switching of neon sign transformers. These instruments can be used also in an atmosphere containing fumes which would affect normal switching contacts, or where an exposed arc could be potentially dangerous.

Circle **8A** *for further details.*

Elgastat Major Mark II

THE Major Mark II is developed from the Elgastat Major, which has become standard equipment in academic and industrial research for producing deionised water.

Mercury tube timer Type SAT



Elgastat Major Mark II deioniser

The following improvements are incorporated in the Mark II:

1. All exposed components are now made from corrosion-resistant plastic. The unit may therefore be used in corrosive atmospheres.
2. Flow rates: Equilibrium water (4 megohms/cm⁺) may now be drawn at the rate of up to 10 gallons (45 litres) per hour.

   Distilled quality water (500,000 ohms/cm⁺) can be drawn at the rate of 20 gallons (90 litres) per hour.
3. Two versions are available:

   Where the requirements are, in the main, for commercial grade distilled water, a capacity and exhaustion indicator is incorporated (Type B.104).

   For critical applications, a conductivity monitor forms an integral part of the unit, and gives an accurate quality check throughout the exhaustion cycle (Type B.104/CON).

A standard modification makes it possible to pipe deionised water to any number of draw-off points. In common with all Elgastats, no regeneration *in situ* is necessary.

Circle **9A** *for further details.*

Petro-chemical Processing

SUPPLIES of forged alloy flanges for use in process and chemical equipment at high pressures and temperatures have long been inadequate, and fittings are imported in large quantities from Germany, Italy and America.

H. & E. Lintott Ltd. have made an intensive study of the position, and as a result, have produced a range of flanges which they are now marketing, under the name "Lin-Flange". It includes welding-neck, slip-on, lap-joint, threaded, blind, socket-type, reducing, orifice and special flanges.

The company does not supply carbon steel fittings, but specialises in alloy steel, whatever the temperature and pressure, above the carbon steel range. It can fulfil most forged flange requirements from stock, those in less common alloys in four to six weeks.

The flanges range from ½ in. nominal bore to 12 in., and cast fittings can be supplied to 48 in. diameter.

Two engineers who recently joined the company are responsible for this important development, and one of them is now in America, negotiating with one of the largest process heater manufacturers for a United Kingdom production licence. The company aims to offer complete installations in due course.

Circle **10A** *for further details.*

Miniature Connectors

THE "Modac" range of connectors have been extended with two new miniature electrical connectors for use in computers and other general electronic installations.

The "Modac" multipoint contact principle has been applied in these two lightweight yet robust connectors. The construction of contacts in all "Modac" connectors is based on the theory that surfaces kept free of oxide film and dirt are more important than contact pressure in maintaining reliable electrical connections.

This is achieved by a series of spring banks which, on closure of plug and socket, are forced apart by a bevelled blade. This action "wipes" the surface of the contact blade, which is then gripped pincer fashion to give an extremely secure connection with a multiple of contact points. The two connectors, which are 23 and 13 way respectively, are both polarised, with each contact capable of carrying up to 10 A at a maximum 250 V.

Circle **11A** *for further details.*

Nylon Chain for Lightweight Drives

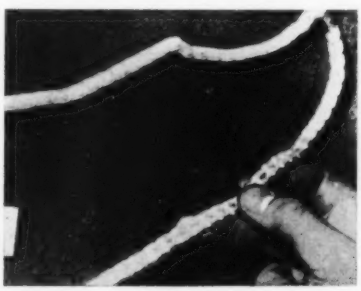
NYLON chain is now being offered to industry for light positive drive applications.

Its qualities include: low inertia; requires no lubrication; noiseless in operation; non-magnetic; good electrical insulating properties; high resistance to chemical attack; good abrasion and wear resistance.

The chain is currently being offered in 8 mm pitch only and will sustain a static load of 5 lb. For continuous or rapidly intermittent operations giving rise to pulsating loads it is recommended that the driving load should not exceed 3 lb.

It is ultimately intended to add other sizes of nylon chain to the range as demand becomes known.

Circle **12A** *for further details.*



Nylon chain

Four point temperature recorder

Four Point Temperature Recorder

THE transistorised four point temperature recorder has a 10 in. diameter chart and operates from the normal 50 cycles mains supply. Resistance bulbs are used as the temperature sensitive elements and low range spans are easily achieved.

The use of transistors has significantly reduced the power dissipated in the instrument and has resulted in improved performance and greater reliability. Particular features are the new improved stability control and the very high reproducibility. The instrument is also available as a single point recorder with electrical or pneumatic control.

Circle **13A** *for further details.*

Elapsed Time Indicator

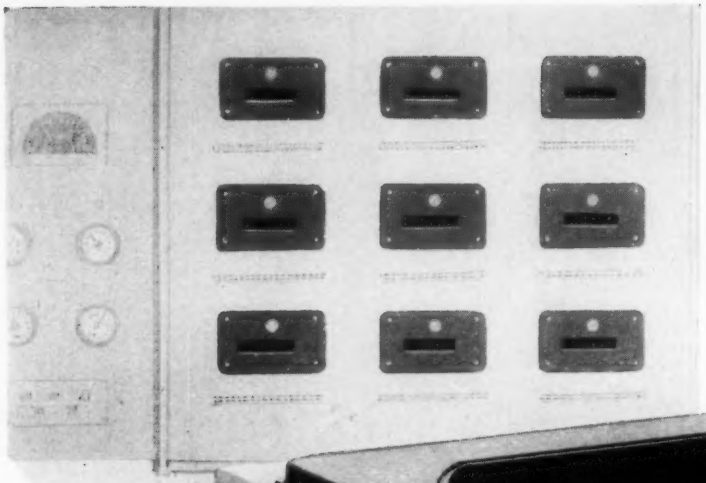
THE elapsed time indicator is an instrument which registers the true operating hours of a vehicle or a machine. This information is invaluable when assessing maintenance requirements. In addition, knowledge of the load or utilisation factor of machine tools, fork lift trucks, and production equipment of all kinds is essential for working out the most effective methods of daily operation.

Basically, the new version is designed with a double-skin instrument case, the mechanism being mounted internally on beryllium copper-leaf springs. The balance staff, balance wheel and armature assembly are jewel mounted, and a very rugged construction is the result.

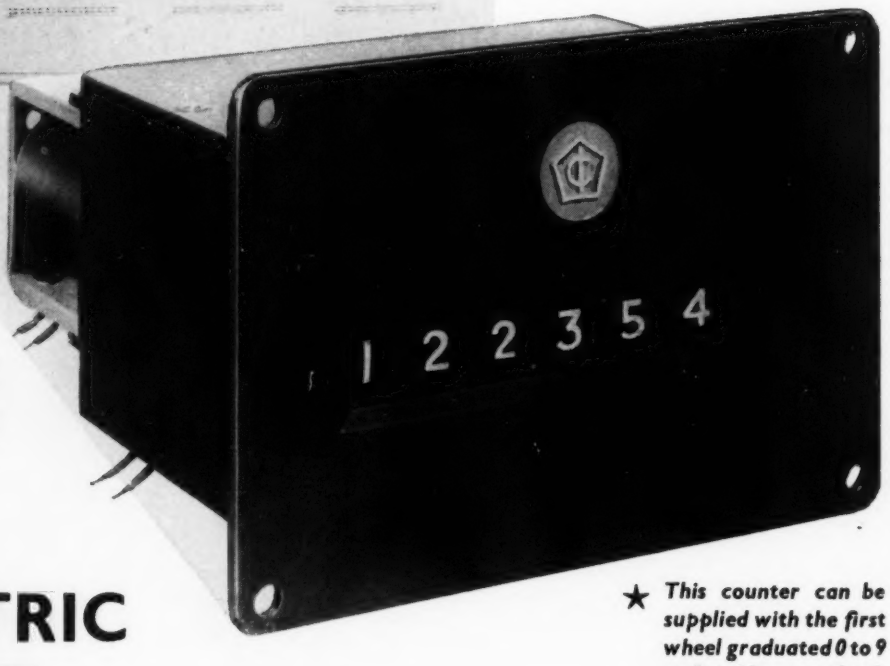
The four leaf springs, spaced 90° apart, carry the complete mechanism, which is then inserted in a polythene case, the springs being located in grooves moulded in the case. This assembly is then installed in a steel outer case, and electrical contact is made through insulated terminals in the rear.

The dial glass is located in a recess of the polythene case, and a specially contoured rubber sealing ring, maintained in position by the bezel, completes the sealing.

Circle 54 for further information



a NEW
HIGH SPEED
PANEL MOUNTING
ELECTRO-MAGNETIC
COUNTER



NOW
With
INSTANT
ELECTRIC
RESET

★ *This counter can be supplied with the first wheel graduated 0 to 9 or 0 to 11 as standard.*

This counter embodies all the well tried features of our Type 100 Electric Counters, plus electric reset. This form of reset is particularly useful where a number of counters are required to be reset at the same time.
Coils for both resetting and counting can be supplied for operation on the following voltages:—
24/43 volts D.C., 110/115 volts A.C. 50 and 60 cycles, and 230/250 volts A.C. 50 cycles. A further model is now available with improved push-button manual resetting facilities which ensure that the counter is virtually sealed.

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COUNTING INSTRUMENTS LTD., 5 Elstree Way, Borehamwood, Herts.
Tel.: ELStree 1382 (4 lines)

Elapsed time indicator

Apart from being completely sealed against ingress of water and dust, the instrument movement is electrically insulated from the case and, therefore, the case does not provide a connection to earth as on earlier models.

Elapsed time can easily be read in hours and minutes to the nearest 15 seconds, and timing accuracy is better than 15 seconds in 24 hours.

The basic timing mechanism remains the same, but improvements have been made in general constructions. For example, the drive between the centre shaft and the hour counters was previously by means of a 1 : 1 reduction gear, causing unnecessary friction and loss of energy. Now the drive is taken from the centre shaft to the hour counters.

Circle **14A** *for further details.*

The Audco Annin Valve

THE Audco Annin valve has as its basic form a globe body designed to provide for conversion into straight through, angle, or three-way forms with a minimum of parts. The valve is of split design and consists of a body and adaptor. This type of construction provides a single seat design which retains an internal contour of the same area as the relating pipe size. The body flanges retain the seat ring in perfect alignment with the valve body. Valve plugs are contoured to provide either linear, percentage or semi-throttle characteristics.

The standard threadless valve seat unit provides easy replacement without shop equipment.

The Audco Annin Domotor

The Audco Annin Domotor is a precise positioning and fast pneumatic operator. The unit consists of a dome with built-in positioner and piston providing power, stability and positioning accuracy. A deviation of but a few thousandths of an inch of the piston rod from its rest position is sufficient to provide a restoring force of the maximum-rated value. The unit also provides rapid response with no tendency to over-shoot the control position.

The cylinder-operated valve combines the advantages of the Audco Annin body with a powerful, fast acting cylinder operator. Air or gas pressure to 150 p.s.i. may be used, and remote operation may be accomplished by means of solenoid pilots or pneumatic controls. These valves are used for open-shut duties.

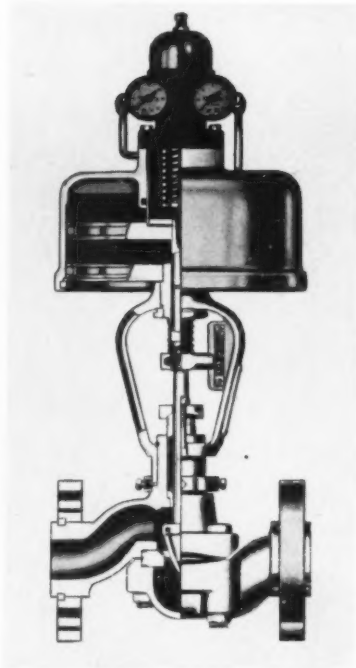
The manual control valve provides a group of valves suitable for precise throttling of flow rate and tight closure. They are particularly well adapted to manual by-pass services, manual flow control for batch and other non-continuous operations.

Valves are available to A.S.A. ratings 150, 300, 600, 900 and 1,500 lb, and in sizes ¾ in., 1 in., 1½ in., 2 in., 3 in., 4 in., 6 in. and 8 in. A wide variety of materials will ultimately be available, but at present valves are being produced in carbon steel with stainless steel trim and in stainless steel complete.

Separable flanges are available on all 600 lb A.S.A. rating bodies in sizes 1 in. to 4 in. 150 lb, 300 lb and 600 lb raised face flanges can be interchanged at will.

Circle **15A** *for further details.*

Audco Annin Domotor



Remote Control by V.H.F.

A REMOTE control and indication system employing a v.h.f. radio link is being manufactured. The system is employed for remote control and the position indication of sixteen water pumps raising and transferring water from an oasis to an installation of the Qatar Petroleum Company in the Persian Gulf. The control signalling takes place at 173·5 Mc/s whilst indications back to the control station are transmitted at 160·3 Mc/s with two-way speech communication on a frequency modulated channel at 167 Mc/s. The control station and the controlled pumps are seven miles apart. It is felt that this job points the way to the future remote control of public utilities. At the present moment, private radio transmission between fixed points is not permitted by the G.P.O. but there is every likelihood that this will change soon and then it will be possible to have remote radio control of gas, water and electrical installations.

Circle **16A** *for further details.*

Audio Oscillator with up to 6W Output

THE Type 440 audio oscillator has the feature of providing an output of up to 6W into 15 ohms or 600 ohms over the frequency range of 20 c/s to 20 kc/s.

The stability of frequency and amplitude, together with the high output at low distortion, make the Type 440 audio oscillator an ideal instrument for measurements of distortion, gain and frequency response of audio amplifiers and associated equipment. The output is such that it will adequately drive direct, loudspeakers or small vibration generators.

Circle **17A** *for further details.*

Mallory 1000

MALLORY 1000 is a machinable high density material composed of tungsten, nickel and copper and made by a special powder metallurgy technique. It has a uniform structure, high strength and density. As the material may be subjected to all normal machining and grinding processes, it is suitable for the manufacture of components where high mass coupled with high strength and small volume are important considerations, e.g., counterbalances for aircraft control su faces; balances for flywheels; inertia members in such instruments as accelerometers, and as rotating inertia members, where strong precision-machined rotors are required in a limited space.

A further major application of Mallory 1000 is in radiation shielding. By virtue of its physical structure and its very high density, Mallory 1000 effectively absorbs gamma rays and can also be used for the shielding of neutron-emitting fission by-products, provided that the intensity of bombardment is relatively low. Such low-intensity neutron bombardment causes only moderate activity in Mallory 1000.

Mallory 1000 is supplied in special pressed shapes as well as in the form of round and rectangular bars.

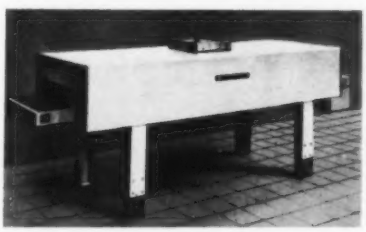
Circle **18A** *for farther details.*

Infra-red Syringe Sterilising Equipment

METROPOLITAN-VICKERS ELECTRICAL CO. LTD. has introduced a horizontal conveyorised infra-red sterilising equipment for central syringe services in hospitals.

The horizontal steriliser is completely automatic (apart from the loading of trays on the conveyor) and since the sterilising time and temperature are pre-set and can only be altered by a responsible supervisor, it is suitable for operation by unskilled workers.

An important feature is a highly



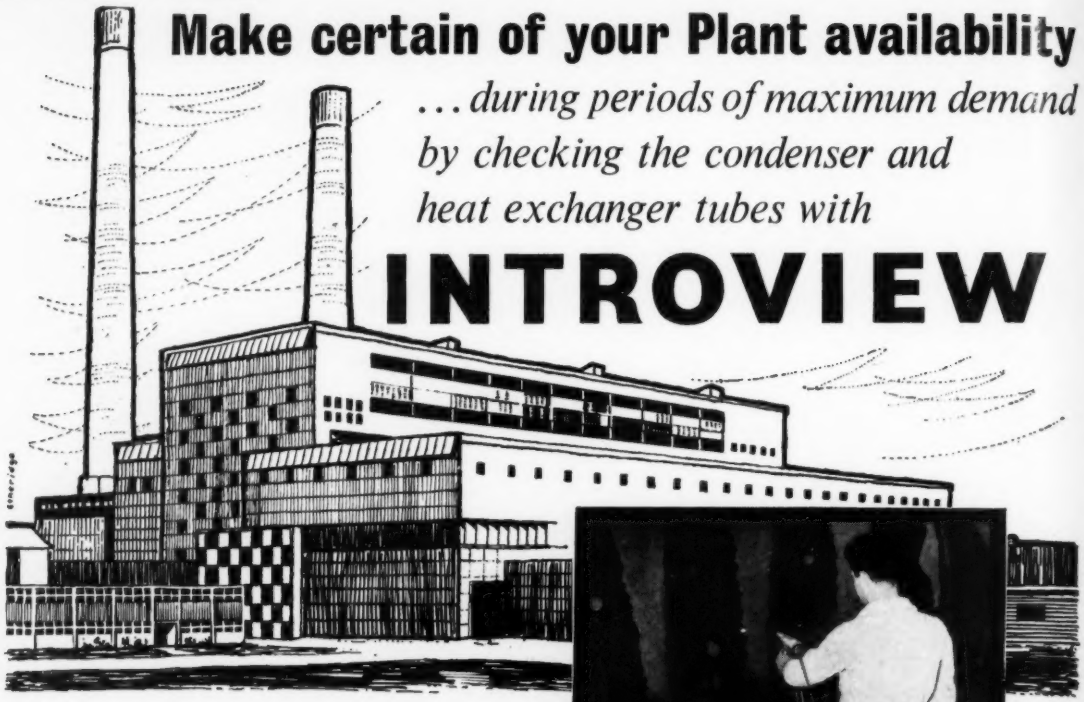
Infra-red syringe sterilising equipment

Circle 55 for further information

Make certain of your Plant availability

... during periods of maximum demand by checking the condenser and heat exchanger tubes with

INTROVIEW



Planned maintenance includes the inspection of all non-ferrous tubing during the shut-down period of the steam plant. "Introview"* provides a speedy and complete check of all non-ferrous tubes whilst *in situ.*

The "Introview" equipment is for the non-destructive testing of non-ferrous materials and employs eddy-current principles. It comprises a small probe which is drawn through the tubes under test, the electrical output from this probe being recorded on the "Introview" recorder instrument, thus providing a permanent graphic record of tube condition. Additional components include an electrical power pack, compressed-air probe injector and automatic winching unit. All units are small and compact and have been designed for ease of transportation and operation in confined areas at high speed.

ENGINEERING, MARINE, WELDING & NUCLEAR ENERGY EXHIBITION
APRIL 16th TO 30th STAND NO. 9 ROW F GRAND HALL

* Manufactured and marketed under licence from Imperial Chemical Industries Ltd.

SPERRY

GYROSCOPE CO. LTD.

(INDUSTRIAL DIVISION)

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efficient heat insulation system, which prevents heat losses and ensures that the casing of the oven remains cool. Also incorporated is an automatic temperature control device; this ensures that sterilisation times and temperatures are consistent regardless of the load (number and size of syringes, etc.) and the ambient temperature.

Circle **19A** *for further details.*

Silver Anode

JOHNSON, MATTHEY & CO. LIMITED announce that they have recently investigated the influence that different metallic structures and physical conditions have upon the performance of high-purity silver anodes in silver plating baths. Several important conclusions were reached and as a result the company has developed a new type of silver anode.

Matthey C.A. anodes, because of special processing, have a structure consisting of small equi-axed grains and are particularly resistant to flaking or shedding in high-speed plating baths. Moreover, the anodes show remarkable tolerance to variations in the composition of the electrolyte and in anode current density.

Information on research results is available.

Circle **20A** *for further details.*

New Range of Small Nitrogen Plants

FIVE models are available of a range of small, compact and completely self-contained plants for the supply of liquid or gaseous nitrogen. Between them they cover capacities from 1·5 to 24 litres of liquid nitrogen per hour or 2 to 30 standard cubic metres of gaseous nitrogen per hour.

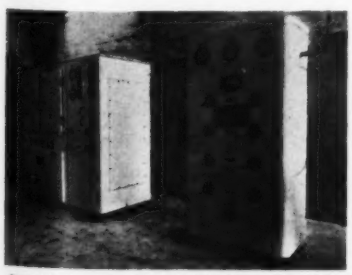
These plants are designed to produce nitrogen of up to 99·9% purity by the liquifaction and fractional distillation of air. Applications include the provision of liquid nitrogen for petroleum gas analysis on remote oil field sites and liquid or gaseous nitrogen for general laboratory, refinery and chemical works usage.

The nitrogen plants comprise four principal sections which carry out the following functions: compression of the incoming air; removal of carbon dioxide; drying; condensing and subsequent separation of nitrogen by fractional distillation.

The use of regenerative driers, a caustic soda scrubber, and cross counter current heat exchangers, ensure long trouble-free runs. The drying and separation sections are each housed in stove-enamelled cabinets. Foundations are required for the high pressure multi-stage compressor and caustic soda scrubbing tower but these units can be housed in positions remote from the other two.

The plants are fully instrumented, completely wired up electrically and only require interconnecting pipework and electricity supply cables to be installed by the user.

Circle **21A** *for further details.*



Liquid nitrogen plant (L.N.10) showing (from right to left) the regenerative H.P. drier unit, the separation unit, with dewar filling and cold cabinets and freon compressor below

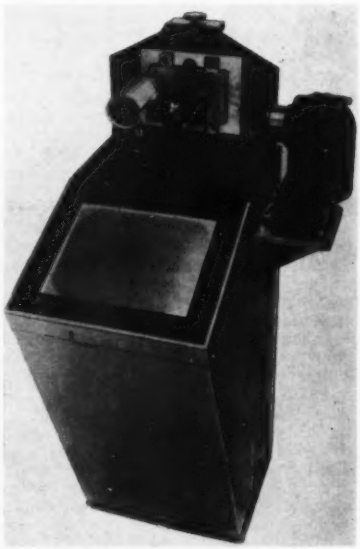
Shadomaster Can Seam Projector

THE Shadomaster can seam projector provides variable, light contrast facilities. It is fitted with a can holding fixture, a special optically worked surface illuminating mirror and an independent overlay optacology chart for taking screen readings.

This special purpose Shadomaster projector will be in general production shortly.

The price of this projector, complete and ready for use, including a spare chart and mirror, is £248.

Circle **22A** *for further details.*

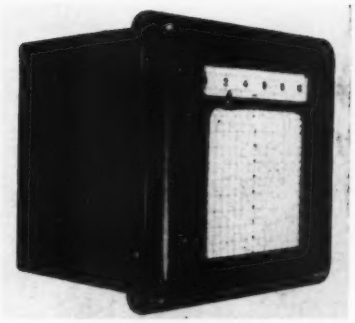


Shadomaster can seam projector

Electronic Strip-chart Recorder

THE Mark 3 Multelec high-speed electronic strip-chart indicator-recorder which has been hitherto confined to nuclear-energy and other special applications is now available for general industrial instrumentation and control. The Mark 3 is at present available for the precision measurement of millivoltage, and also temperature, in association with thermocouple, resistance thermometer or radiation pyrometer.

The recorder has an operating speed, with no pointer "overshoot", of two seconds for full-scale travel; all-mains operation with continuous standardisation; re-designed chart-drive unit, permitting variation of chart speeds from 1 in. per hour to 4 in. per minute; 10 in. chart width and pen travel; high-gain amplifier, covering a wide range of a.c. or d.c. input conditions; sealed-unit



Mark 3 Multelec electronic recorder

maintenance-free servo-motor with built-in tachogenerator; and a synchronous converter. The last three components, developed as a result of research, are available for other applications as separate units.

The Mark 3 Multelec is available in single or multi-point form, with point-cycle times of 5, 10 or 20 seconds, depending on application, enabling up to sixteen variables consecutively to be measured and recorded with laboratory accuracy.

Circle **23A** *for further details.*

High-speed Flash Tube

A NEW range of high-speed cathode ray flash tubes which produce a flash of the same order of intensity as a gas-filled electronic flash tube, such as is used in photography, has been introduced by the Electronics Department of Ferranti Ltd.

These tubes, known as the CL60 and CL70 series, light up all over simultaneously in contrast to the normal behaviour of the cathode ray tube, and have the additional advantage that flashes can be repeated much more rapidly. Flashes of up to one million per second are obtainable. It is also possible to produce long flashes, and flashes which contain an internal fine structure consisting of a multiplicity of smaller flashes.

The lamp can be arranged to flash at the beginning and end of a given interval of time or pulse. Alternatively, two different coloured lamps could be used to mark the beginning and the end.

The basis of this operation lies in light from the flash being shone on to a disc which is rotating uniformly at a known synchronous speed. The disc is black with a single radial white line and the two flashes will thereby produce an angle which can be appreciated in relation to a fixed scale around the outside of the disc. The flashes can be made sufficiently bright to enable the eye to retain the image for an appreciable time. A tube of this type could therefore be used for such applications as examining the bounce on relay contacts, ignition timing and on other mechanical devices. The technique is particularly suitable in instances where more than one pulse is to be examined. For this application, all that is required is the flash tube, the associated circuits for power supply and a small synchronous motor.

There are three different types of tube currently available from Ferranti Ltd. The CL60 series are triodes, 3¼ in. in diameter, the CL70 series are miniaturised,

High speed cathode ray flash tube

1 in. in diameter and the CE1 series are diodes, 6 in. in diameter. Tubes can be made with phosphors of all colours including ultra-violet and infra-red. It is also possible to produce "white" light free from the spectral line structure associated with gas-discharge lamps and extending over specified spectral ranges.

An interesting application of this vacuum type of flash tube is its use, in conjunction with Ferranti solar batteries, in the examination of binary or other position-indicating scales at high speed. By suitable choice of phosphor, the characteristic emission of the flash tube can be made to match the peak sensitivity of the solar cell.

Circle **24A** *for further details.*

Packaged Boiler

A NEW type of horizontal packaged boiler with high thermal efficiency has been designed exclusively for burning oil fuels and gas.

A range of steaming capacities from 4,000 to 11,000 lb per hour are available, and if used as hot water units, outputs from four million to eleven million B.T.U.s per hour are available. Smaller units are also under development.

The boiler requires a minimum of labour supervision as it is fully automatic and there are no ashes to contend with. A full complement of controls is fitted including an over-riding low water cut-out, which complies with leading insurance companies' latest requirements.

Circle **25A** *for further details.*

P.T.F.E. Insulated Instrument Wire

P.T.F.E. instrument wire for use in electrical instruments and equipment is now available from Siemens Edison Swan Ltd. Initially, two types are available: for use at voltages up to 500 volts r.m.s. and 1,000 volts r.m.s. They are to Ministry of Supply (Air) Specification EL1930 Types B and C.

The wire, for use where conductor temperatures of between 75°C and 250°C are experienced, has either single or stranded annealed copper wires each silver plated to a radial thickness of not less than 0·00003 in.

The P.T.F.E. is extruded, which permits a high degree of concentricity to be obtained.

Whilst the insulation is not loose, it can be cleanly stripped for connections.

Electrically, P.T.F.E. has high dielectric strength and low power factor. It offers complete chemical resistance to all known solvents except molten sodium and fluorine gas. P.T.F.E. instrument wire is non-chafing owing to the low coefficient of friction: it is highly flexible, and will not harden or perish.

Circle **26A** *for further details.*

Flow Recording Chlorinator

THE chlorinator is now available with a flow recorder incorporated in its construction.

The recording unit is installed in the head of the equipment and readings can be taken at a glance through a glass panel of ample proportions which opens to allow easy access to the unit without interfering with the chlorinator. The recorder operates from the metering differential, which is transmitted to coupled bellows and is obtained by connections across a specially designed valve inserted between the vacuum regulator outlet and the meter inlet. The vertical movement of the bellows coupling controls the pen driving mechanism.

A continuous recording is provided on the seven-day drum chart which is calibrated in lb of chlorine per hour and which displays a generous area to facilitate the observation of past readings. The drum is operated by an eight-day clockwork mechanism

The cabinet is made of polyester-impregnated glass fibre and thus requires no repainting. The most important components of the chlorinator, such as the injector block, chlorine regulator, valve body and piping are made from plastic materials which have been specially developed for their chlorine and water resisting properties. Corrosion resistant alloys are used where metal parts are unavoidable.

To enable the operator to alter the capacity of the instrument the chlorine flow meter and the control valve stem and sleeve assembly are situated in an easily accessible position as indeed are all the major components.

This chlorinator is produced in two types:—Type NMF for manual operation and Type NAF for fully automatic dosing, each type being available with thirteen meter sizes ranging from maximum capacities of 0·125 lb to 40 lb of chlorine per hour with a control range of 10 to 1. A supply of charts, sufficient for two years' operation, calibrated according to capacity, is provided with each instrument.

Several safety features are incorporated in its design which is basically simple and the instrument can therefore be operated by unskilled labour.

Circle **27A** *for further details.*

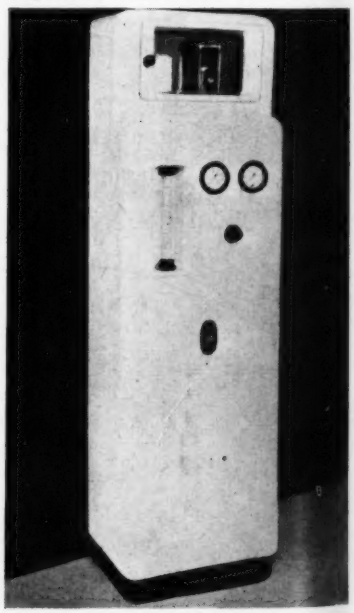
Portable Hydraulic Test Set

THE Madan portable hydraulic test set has been designed for applications which are essentially mobile. Everything needed to carry out an hydraulic pressure test on site is included and the set only needs to be connected to a compressed air line as a source of power. On isolated sites where no compressed air line is available the set may be operated from nitrogen or compressed air bottles.

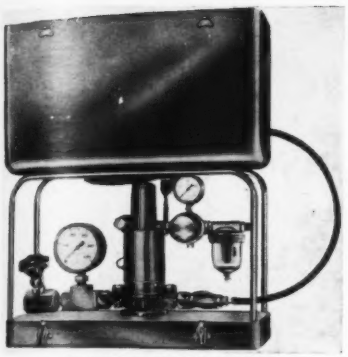
The pump works on the principle that the air pressure applied to a large air piston imparts a thrust to an hydraulic ram of smaller area and creates a high hydraulic pressure. This reciprocating action gives a continuous flow.

The set operates from an air supply of not more than 100 p.s.i. An air pressure regulator control valve is incorporated which enables all intermediate hydraulic pressures within the range of the pump to be accurately determined and which makes it completely safe for the operator to leave the item under test, as the desired test pressure is never exceeded. On reaching the necessary pressure the pump becomes dormant on a closed circuit, using no further air. Should there be intermittent leakage from the component or circuit under test, the pump will move automatically until the loss is made up.

The test set comprises an Airhydropump, air pressure regulator, air filter, hydraulic filter, air and hydraulic gauges, hydraulic stop valve, reservoir and six assorted adaptors for various B.S.P. connections.



Flow recording chlorinator



Portable hydraulic test set

The case and base mounting are made of moulded glass fibre. Pump and control valves are of non-ferrous metal or stainless steel and all air and hydraulic packings are of the fabric reinforced synthetic rubber type suitable for water, kerosene, and the majority of hydraulic fluids in regular use.

The overall size, ready for carrying, is 21 in. long × 16 in. high × 8¼ in. wide and the complete set weighs 38 lb. Delivery is generally ex stock and in no case will exceed 2 to 3 weeks.

Circle **28A** *for further details.*

Resin-cast Neon Stabilisers

THESE are available in a double-ended (tubular) or a single-ended (flat) design in the following range: 370 V (G-M tube), 500 V, 750 V, 1·1 kV (G-M tube), 1·5 kV, 2·0 kV, 3·0 kV, 3·5 kV, 4·0 kV, 4·5 kV and 5·0 kV.

The encapsulated circuit is a chain of neon tubes with a series/parallel striking network and stabiliser over the range of 250 mA to 1 mA.

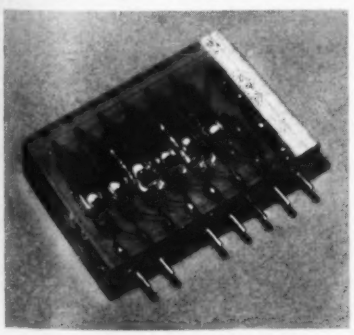
To overcome slow stabilisation due to lack of residual ions after storage, these components are also available with five microcuries of radium sulphate embedded in the structure.

The initial striking voltage is approximately the burning voltage due to the circuit employed and the manufacturing tolerances on the burning voltage are 10%, 5% or 2½%.

Special stabilisers with voltages other than the above can be manufactured to order.

Prices range from £1 10s. 0d. to £12 each depending on voltage and currents required. Delivery in three to four weeks.

Circle **29A** *for further details.*



Resin-cast neon stabilisers

Pressure Resistance Transducers

THE pressure responsive element consists of a hardened beryllium copper Bourdon tube, the movement of which is proportional to the applied pressure. This tube movement actuates a lever system to traverse a wiper over a precision wound potentiometer. To ensure maximum response and to obviate linkage backlash, all pivots and bearings are fitted with miniature precision grade ball bearings. The Bourdon tube is brazed into the support casting and the end-piece.

The pickup wiper consists of two blades to ensure that electrical continuity is maintained even under conditions of vibration. An overload breaklink is incorporated in the lever system to prevent the wiper leaving the potentiometer on pressure overload.

Types and Pressure Ranges

Two types are available at present. A fixed range model, such as 0-1,200 p.s.i., and a suppressed zero model, such as 250-500 p.s.i. On the suppressed zero model the Bourdon tube movement from zero to the start of the range is taken up by the linkage. All instruments will withstand 25 per cent of the maximum pressure range overload without derangement.

These instruments can be supplied filled with silicone fluid to provide damping when they will be subjected to conditions of vibration and acceleration, as in aircraft.

Circle **30A** *for further details.*

Barrel Dispenser

AN air-operated barrel dispenser, fully automatic in operation, will deliver liquids without fluctuation or pulsing at the rate of 15 gallons per minute, dependent on the type of the vessel and the viscosity of the liquid.

Other than the delivery valve, which is manually opened and closed, there are no moving parts and thus deterioration through wear is negligible. There are no vanes, rotors or pockets where contamination could take place and consequently all that is required when changing from one liquid to another is one simple flush out.

The dispenser consists of a solid drawn steel tube riser pipe with aluminium valve body, air regulator body and barrel adaptor. The valves, stems and air regulator piston are made in brass, and the delivery valve is designed to give minimum drip after serving. The barrel adaptor on the standard model fits 2 in. B.S.P. thread; the air regulator has a ¼ in. B.S.P. female thread.

The air control valve ensures that the storage vessel (40 gallon drum, etc.) is not subjected to more than 5 lb per square in. pressure. In addition, an excess pressure safety valve is fitted to bleed away excess air pressure in the unlikely event of the air control valve not functioning.

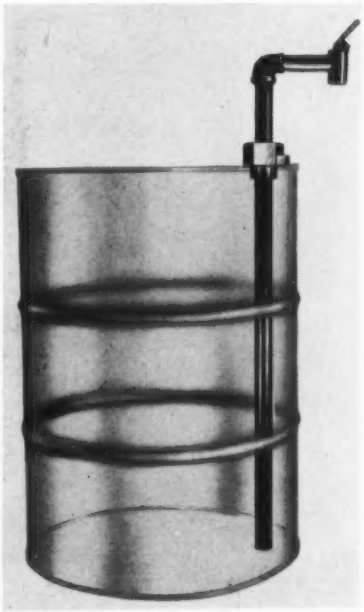
In operation, the barrel cap is opened, the dispenser screwed in and connected to an air supply. No priming is necessary and the instrument will never dry out. Being pressure operated, it will deliver over long factory lines.

Preventing expensive waste and the manhandling of heavy barrels, the dispenser does not require a continuous supply of air. Once charged, it will maintain its own pressure until an appreciable drop of level is reached.

Known as the Suba Model 108 air-operated barrel dispenser, the instrument can be manufactured in stainless steel or other suitable materials when contamination has to be avoided, i.e., edible oils, etc. It can also be used as an integral part of a closed circuit system in conjunction with dial meters, float level control systems and pressure distribution circuits.

Circle **31A** *for further details.*

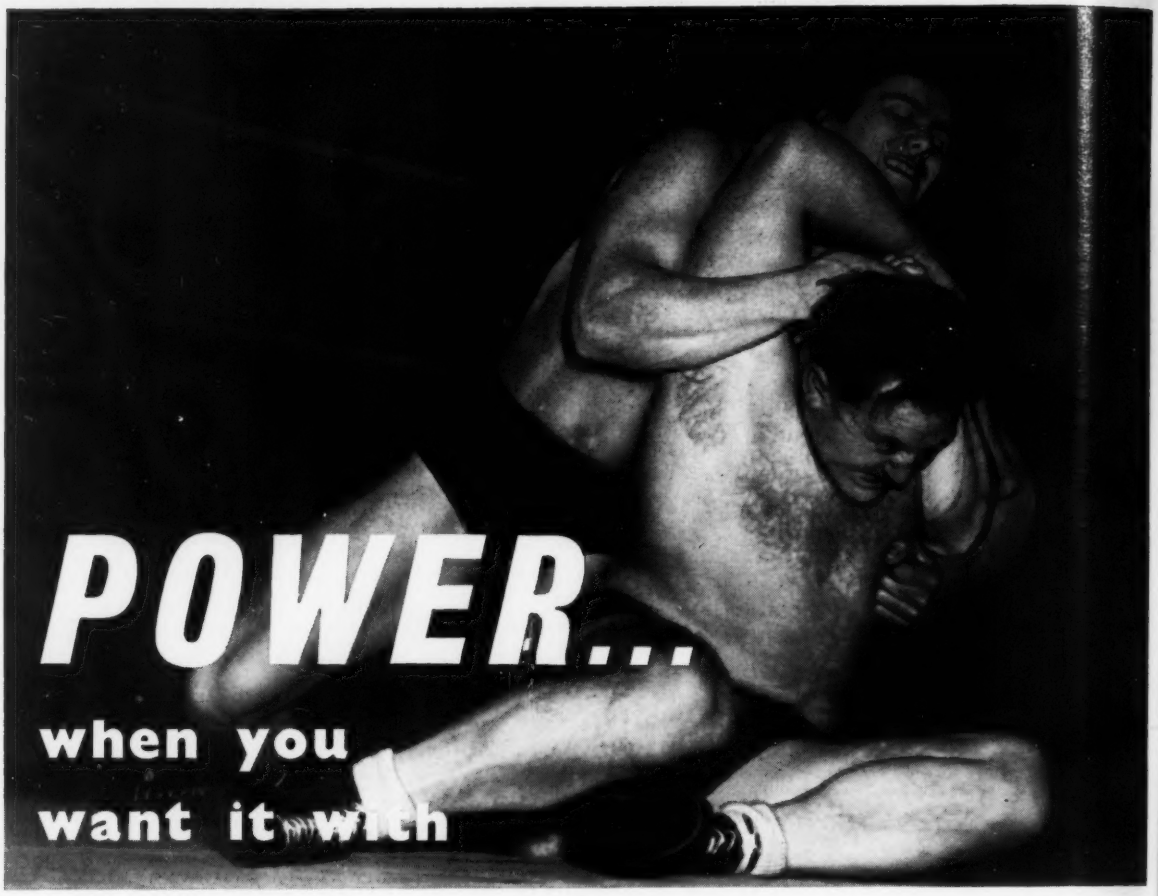
Barrel dispenser



Compound Angle Sine Tables

THE feature of this table is the substitution for the conventional hinged bearing at 90° of a hemisphere riding in a spherical seating and permitting any angle up to 45° to be set as a single or compound angle. The advantages of this design lie in its increased rigidity, its higher accuracy and the fact that the working surface is always over the centre of the base. No wear or slackness can develop as in the case of the conventional hinged type. The work-table provided by the upper surface of the hemisphere is provided with tee slots for clamping purposes.

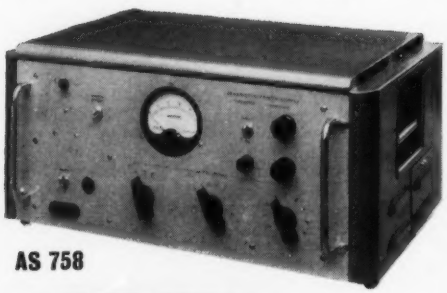
The sine settings are obtainable by the insertion of slip (or block) gauges underneath two hardened precision spheres which are spaced exactly 90° apart, the gauges resting on the appropriate hardened platforms on the base. One of the hardened spheres is located against the vertical face of a detachable straight-edge to ensure that the first inclination of the table is in a plane parallel to the datum abutment face machined on the base, the second inclination for a compound angle automatically being in a



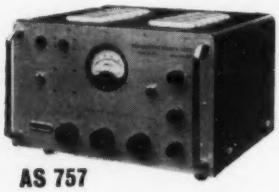
SOLARTRON

Stabilised transistor power supplies

Solartron pre-packaged Transistor Power Supplies, either as completely enclosed bench units or as sub-units, save untold time and trouble for manufacturers who make or use equipment that employs transistors. The advantage of a Solartron unit is that it is handy, compact, adaptable, and under all circumstances absolutely reliable and tested. The output voltage is completely stable so that you can always eliminate the power unit from consideration as a possible source of trouble. *Write now for full descriptive literature, to The Solartron Electronic Group Limited.*



AS 758



AS 757

AS 759

	AS 757	AS 758	AS 759	AS 852	AS 854	AS 855
	Bench	Bench or rack	Sub-Unit	Bench or rack	Sub-Unit	Sub-Unit
Output voltage :	± 0 – 50	± 0 – 30	± 1·5 – 13·5	± 30 – 50	± 11·5 – 32·5	± 23·5 – 38
Output current :	0 – 1A	0 – 10A	0 – 1A	0 – 10A	0 – 1A	0 – 1A
Output resistance :	0·01 Ω	0·01 Ω	0·01 Ω	0·01 Ω	0·01 Ω	0·01 Ω
Output Z to 100 Kc/s:	0·2 Ω	0·2 Ω	0·2 Ω	0·2 Ω	0·2 Ω	0·2 Ω
Stability factor	200 : 1	150 : 1	200 : 1	150 : 1	200 : 1	200 : 1
Ripple and noise (peak to peak) :	1 mV	1 mV	1 mV	1 mV	1 mV	1 mV
Mains input :	90/130 Volts, 200/240 Volts. Permissible deviation ± 7%					
Dimensions :	12½"× 8"× 13" (33x21x33cm.)	22"× 10½"× 16" (56x27x41cm.)	7½"× 5¾"× 5½" (18x15x14cm.)	22"× 10½"× 16" (56x27x41cm.)	Appx. 8"× 6"× 6" (20x15x15cm.)	Appx. 8"× 6"× 6" (20x15x15cm.)
Appx. weight :	25 lbs. (11·5 kg.)	55 lbs. (25 kg.)	7½ lbs. (3·5 kg.)	60 lbs. (27 kg.)	8 lbs. (3·8 kg.)	8 lbs. (3·8 kg.)

THE SOLARTRON ELECTRONIC GROUP LTD
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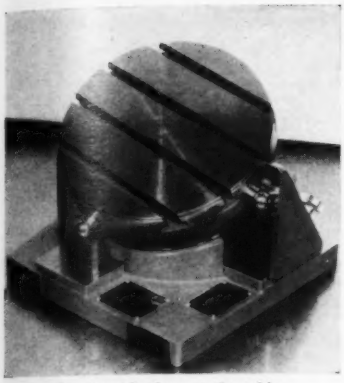


Compound sine angle table

plane at right-angles to the first setting.

When setting is completed, the slip (or block) gauges are removed and the table locked by tightening the nut to secure the central bolt. The wedge action of the hemisphere in the seating so assists this operation that only light pressure is required on the spanner.

The complete range of tables, which are accurate to within ten seconds of arc, can be used equally well for the inspection of jigs and gauges and for the manufacture of components in the machine shop on grinding or jig boring machines.

Circle **32A** *for further details.*

Arca Schaevitz Linear Differential Transformer

THE Schaevitz linear differential transformer is based on the induction link principle for the production of an electrical signal having a linear relationship with movement.

The unit consists of a coil assembly having a core moving freely within it, but not in physical contact. The coil system is made up of three sections, a central primary winding, and two secondaries, at either end of the unit. Linking the coils through the magnetic flux lines, the core is designed to vary the voltage induced in the secondaries by the voltage imposed on the primary as a result of its position relative to the coils.

In the central or null position the voltages induced in the two coils are equal and of opposite phase. As the core moves away from the central position, the voltage in one coil increases as that in the other decreases. By series opposition connection the output from the secondaries thus increases from a zero value at the central point, and reaches its maximum at each end of the travel of the core. The voltages obtained at the ends of the travel are equal in value, but opposite in phase.

Linear differential transformer

The unit can therefore either be used from the zero to one of the maximum values, i.e., always travelling from middle to one end or the other, or used through the central positions if the circuits take into account phase reversal. It can, furthermore, be used purely on phase reversal over the narrow band over the central part of the travel. Alternatively, it can be used with the major part of the travel from centre to end, with a special signal under certain conditions caused by phase reversal a short distance from centre, in the opposite direction to normal.

Over the specified range of travel of the unit, a linear relationship will hold between the travel of the core and the output voltage. This linearity is independent of the burden imposed on the secondaries.

A phase difference occurs between the primary voltage and the secondary output, which is a matter of design choice, as it is a function of the design of the unit, and the operating frequency. This phase difference is, moreover, substantially constant over the working travel of the core, between central and end positions of its travel. At the centre point there is an abrupt phase reversal over 180°, the sharpness of this transition again being a factor which can be modified by design.

A wide range of standard transformers is available together with special purpose units, designed as the result of demands for particular applications. Units are available for core movement as small as 0·005 in. to several inches, with a corresponding range of output voltages, from a few millivolts to outputs in the region of 10 to 15 volts. This voltage is a function of operating frequency. The smallest size of this transducer is $\frac{3}{4}$ in. in length.

Frequencies for use with the transformer are normally in the 50 to 20,000 c/s band, but special purpose designs can be prepared for use beyond these limits.

Coupled to Bourdon tubes, bellows, floats, and similar devices, the unit can provide signals for all process conditions. The use of glands for such applications as differential pressure measurement, level, i.e., travel of the core in a gas or fluid which must be isolated from the coil, is eliminated by the use of units having an annular clearance between the core and the coil assembly, sufficient to permit the interposition of the necessary sealing partition.

Suitable arrangements of core and coil enable it to be used for the measurement of acceleration, mechanical vibrations, and mechanical strains for weight indication, etc. Normal temperature limits are −60°F to +225°F, but special constructions are available to cater for temperature limits beyond these.

Costs are £12 10s. 0d. and delivery is one month.

Circle **33A** *for further details.*

Signal Generator

AN AM signal generator, known as Model 68AM, covering a frequency range of 100 kc/s to 240 Mc/s all on fundamentals, has just been released. The frequencies of 100 kc/s to 240 Mc/s are spread over eight bands, and the total scale length is 58 inches.

Signal generator

The ranges are continuous with a calibration accuracy of ±1%. A dummy aerial, complete with a coaxial lead and socket, is supplied with each instrument. Five alternative terminations covering a wide variety of applications are available, including a special lead for a.c./d.c. receivers.

The list price is £32 10s. 0d. subject to the usual discounts to the trade.

Circle **34A** *for further details.*

Automatic Distillation Apparatus

RECENTLY introduced to the F. J. Hone range of test equipment for the petroleum industry is the BP-Hone automatic distillation apparatus made under licence from The British Petroleum Company Limited.

This apparatus is based upon a rapid distillation method for the routine testing of refinery products when the value of a single point on the distillation curve provides sufficient information for day-to-day volatility control. Repeatability is better than by standard methods.

The apparatus is entirely automatic and carries out a distillation in a matter of minutes.

10 millilitres of the sample to be tested are introduced into a flask by means of a

Automatic distillation apparatus

pipette. A thermocouple is inserted into the neck of the flask and the receiver is placed in position. The heater is then switched on (using voltage appropriate to the product) by operating button. When the selected temperature is reached, automatic cut-out switches off the heater. The volume of the distillation to the nearest 0·05 ml is then noted, after allowing half a minute for draining. After each distillation the residue in the flask is removed by suction. The complete operation takes no longer than 10 minutes, of which less than three minutes is operator's time.

A booklet containing detailed instructions and wiring diagrams is issued with each unit.

Circle **35A** *for further details.*

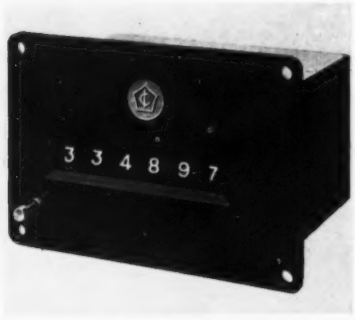
Manual Resetting for Type 100 Range Electric Counter

COUNTING INSTRUMENTS announce an improved method of manually resetting their Type 100 range of electric counter.

Resetting is now operated by means of a push-button located on the left-hand side of the counter, and owing to the construction makes the counter completely dust-proof.

Available for delivery in 6/8 weeks. No change in price.

Circle **36A** *for further details.*



Electric counter

Printing Counter

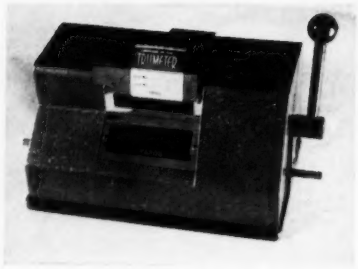
THE Mark 2 printing counter provides an instantaneous printed record and is supplied for use in connection with the counting and measuring of many different products. The Mark 2 printing counter can be supplied mechanically driven by revolution or stroke movements or electrically operated by impulses.

Operation is simple: one movement of the lever resets the counter to zero, simultaneously printing the figures on to a ticket—which is then ejected.

The instrument is fully enclosed. Mechanical details are:

1. Sloping front for easy reading.
   Available with 3 to 6 digits.
   Drive: Rev. stroke or electrical.
2. Counter can be reset to zero by a single movement of the lever and at the same time prints the result on to a ticket roll and automatically moves the ticket roll to the next position.
3. Ticket ejected automatically—can be torn off after every print, or printing on a continuous roll of tickets.
4. In addition, the counter can be made fully automatic, resetting and printing by means of a small electric motor.
5. Indicating numbers next to the printed result can be incorporated, to indicate either code number or letter.
6. Counter of robust construction designed for continuous working.

Circle **37A** *for further details.*



Mark 2 printing counter

Phenolic-dip Protected Capacitors

THE new capacitors, suitable for use over the temperature range −60° to +100°C, are protected by a dip coating of a special non-brittle phenolic material that is mechanically robust. The material is blue in colour and the markings are printed on the surface of the capacitors clearly and durably in white.

Each JMC phenolic-dip protected capacitor is individually adjusted so that any value within the range of each type can be supplied. Two main series are available, eyeleted and fired.

The eyeleted capacitors are assembled from pierced silvered mica plates by means of composite silver-plated eyelets, the design being such that no inter-plate connecting foils are used. The fired capacitors have higher long-term stability than the eyeleted, the plates used being fired into a solid block, a construction that does not necessitate mechanical joints or connecting foils.

Circle **38A** *for further details.*

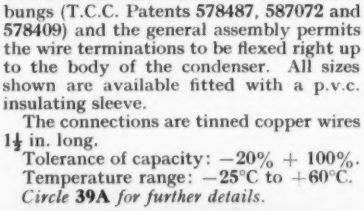
Sub-miniature Tubular Electrolytic Condensers

THE condenser element is hermetically sealed in an aluminium tube with rubber bungs (T.C.C. Patents 578487, 587072 and 578409) and the general assembly permits the wire terminations to be flexed right up to the body of the condenser. All sizes shown are available fitted with a p.v.c. insulating sleeve.

The connections are tinned copper wires 1½ in. long.

Tolerance of capacity: −20% + 100%.
Temperature range: −25°C to +60°C.

Circle **39A** *for further details.*



Sub-miniature tubular electrolytic condensers

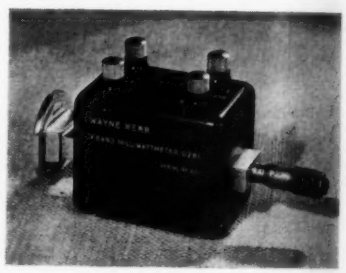
Microwave Milliwattmeter U.281

THIS resistive film bolometer wattmeter is designed to measure microwave power in the range 1 to 100 milliwatts in the band 8·4 to 10·2 kMc/s. The accuracy of measurement is better than ±3%.

Basically the wattmeter consists of a thin resistive film which is mounted symmetrically in the transverse plane of the waveguide. The rise in temperature of this film caused by absorption of incident microwave radiation is used to measure the input power. The temperature change is detected by a thermocouple junction mounted on the film and connected to a sensitive galvanometer.

For the frequency at which the power is to be measured the short circuiting termination is adjusted by the use of a micrometer to ensure minimum reflection of power from the mount. A calibration for the setting of the micrometer against frequency is supplied with each mount which is matched to better than 0·9 voltage standing wave ratio.

When the power is incident upon the element the film undergoes a rise in temperature. This sets up a thermal e.m.f. in the thermocouple junction, the terminations of which are connected to a sensitive galvanometer. The amplitude of the galvanometer deflection is a measure of the r.f. power. An absolute value of the power can be obtained by reference to a d.c. calibration.



Microwave milliwattmeter

Because of the simplicity of construction and use, this milliwattmeter does not suffer from losses in the guides, which are noticeable in thermistor mounts. Hence power measurements to within ±3% may be made.

The original work on transverse film bolometers was carried out by J. A. Lane, M.Sc., A.M.I.E.E., of the Radio Research Station, Slough. Fuller details of this type of instrument are given in the paper written by Mr. Lane and published in the I.E.E. Journal, Part B, Volume 105, "Transverse Film Bolometers for the Measurement of Power in Rectangular Waveguides".

Circle **40A** *for further details.*

Miniature Adjustable Toroid Assemblies

THE object of this development is to produce high frequency adjustable inductances with high Q factors.

The inductance adjustment is obtained by reluctance variation and the range of adjustment is about 10% according to the overall size of the core. The tuning law is linear and advantage of this can be obtained in the use of the adjusting slug as a

Miniature adjustable toroid assemblies

proximity device. The thermal and mechanical stability of the tunable toroids is very good and they can be used in a wide range of applications.

Single toroids can be mounted on a variety of arrangements, a printed circuit arrangement has been developed complying with the B.S.I. recommendations.

Coupled arrangements have also been developed where for high coupling factors a coupling winding can be utilised. These have also been developed for printed circuit applications.

Circle **41A** *for further details.*

Miniature A.C. Chopper Relay

THIS chopper is available with several adjustments and various contact efficiencies. The common features are: (1) size and fixing centres, (2) single or two changeover contacts, (3) special 12-pin "plug-in" or "solder tag" base, (4) dust-proof cover, (5) demountable gasket.

In general, these choppers can be used with any system involving the conversion of low-power voltage signals. They are particularly useful in applications requiring error voltage measurements or null detections and in applications requiring the conversion of minute d.c./d.c. or d.c./a.c. signals for purposes of amplification in computers, electronic and electrical apparatus, servo-mechanisms, etc.

Extensive tests have shown that maintenance-free running periods appreciably in excess of 1,000 hrs are consistently obtained with the 50 c/s 6·3 volt chopper. Further extension of life is usually possible with a re-trim of the contacts.

Circle **42A** *for further details.*

Miniature Ferrite Printed Circuit Pot Core Assembly

THIS assembly, which is enclosed by a half-inch square can, has been developed for transistor circuits, in particular where printed circuits are employed. The tag arrangement on the base complies with the B.S.I. recommendations for printed circuits. The can earthing clips perform the dual function of earthing and retention of the whole assembly. A rubber compression pad maintains pressure against the mating surfaces of the pot cores and inductance adjustment is obtained by a 4 mm screw core. The components are all selected to operate under tropical conditions without deterioration of performance.

The construction permits multi-winding techniques to be employed and sub-assembly to be carried out separately. The bending over of tags prior to dip soldering is facilitated by careful attention to detail and hot tin dipped tags are used to establish good soldering techniques.

The cores can be supplied in several grades of ferrite according to requirements dictated by inductance required and frequency of operation. Qs of 200 are readily obtainable at the lower frequencies and at 20 Mc/s Qs of 100 can be obtained. Work is being carried out with the object of improving the highest frequency Qs. The pot cores have been used up to 40 Mc/s.

The low frequency assemblies can be wound to give 11 mH inductance up to 4 Mc/s with correspondingly less as the material permeability is reduced for higher frequency performance.

The temperature coefficient of permeability can be made for the assembly, less than 100 parts in 10^6/°C.

Circle **43A** *for further details.*

Coil Winding Machine Counts Turns

A COIL winding machine is now available which will wind three coils simultaneously up to 9 in. in diameter and up to 4 in. in width using wires from 14-42 s.w.g.

Reels up to 6 in. in diameter are mounted on the upper reel carriers and reels up to 15 in. in diameter on the heavy reel carriers in rear of the machine. The machine may also be used for "Pack feeds". Four speed ranges are provided: 0/350 r.p.m., 0/750 r.p.m., 0/1,500 r.p.m. and 0/2,000 r.p.m.

A foot pedal controls the rate of acceleration from zero to maximum on any range.

The machine may be provided with up to five predetermining revolution counters and may also be fitted with an "end of layer stopping device" to facilitate hand interleaving.

The Warner reversing mechanism comprises two Warner electric brakes coupled to two worm wheels in constant mesh with two lead screws, and an arrangement of adjustable stops and micro-switches gives positive and instantaneous reversal of direction.

The length of traverse may be adjusted in seconds. The "turns per inch" setting is obtained by means of a plastic handwheel moving against a calibrated scale engraved in s.w.g. sizes or in decimals of an inch if preferred.

A Warner electric brake is incorporated in the head-stock drive and the braking value may be adjusted by means of a plastic knob to suit varying gauges of wire.

The machine may also be fitted with two small pilot lamps showing the instant that a change in direction of traverse has occurred, thus facilitating the setting up for accurate coils, and small push-buttons permit of the traverse being either automatic or varied at will.

The machine is provided with a soldering iron recess and soldering iron socket outlet and a handwheel returns the travelling carriage to its starting position.

A full speed "lock on" foot switch may also be provided whereby having attained full speed the foot pedal remains locked until cutting-out on the predetermining revolution counter.

Circle **44A** *for further details.*

Miniature Toroid Winding Machine

A MACHINE has been produced for winding computer cores down to 2 mm outer diameter. On this diameter core 150 turns of 47 s.w.g. enamelled copper wire can be wound by machine dispersed over a number of windings.

Further development is being carried out with the object of increasing the total number of turns to a value of 200 and to decrease the wire gauge to 46 s.w.g. Where winding requirements exceed the present capabilities of the machine, the completion can be made by hand.

Cores of larger size can be wound with no difficulty.

Encapsulation in a large variety of forms can be done. Where encapsulation is not required, colour coded wires can be used.

48 s.w.g. enamelled copper wire can be wound satisfactorily with the machine.

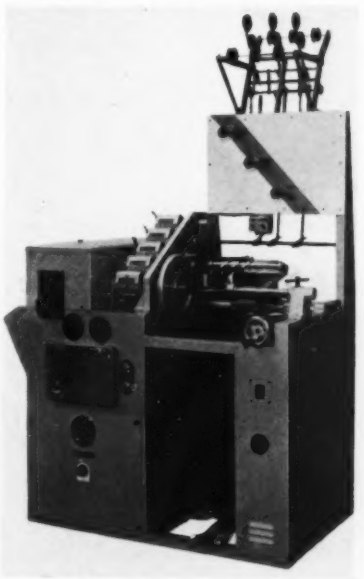
Testing of the wound cores can be arranged to comply with the customer's requirements.

Circle **45A** *for further details.*

Personnel Protection Densitometer

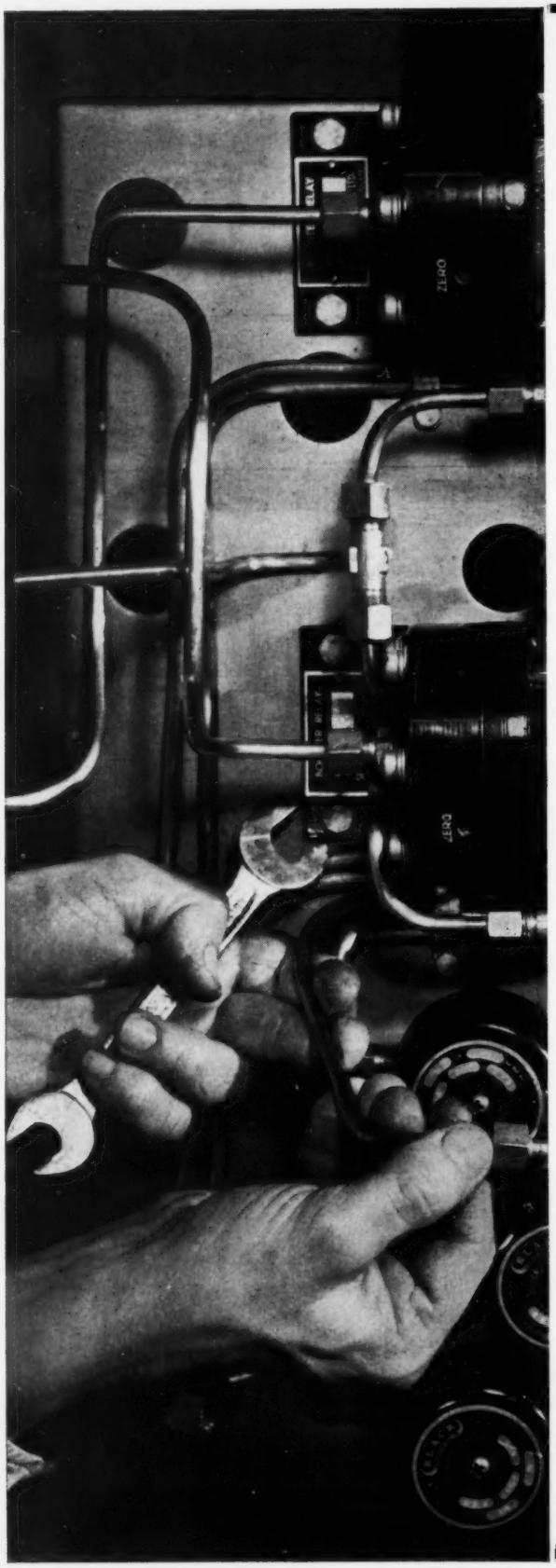
THIS instrument has been designed for the rapid and accurate measurement of density of processed protection film badges used by radiographers and persons engaged in radiography. It enables low levels of density to be measured with a high degree of accuracy and, furthermore, may be used as a precision general purpose densitometer.

The instrument comprises two units, a



Coil winding machine

Circle 57 for further information



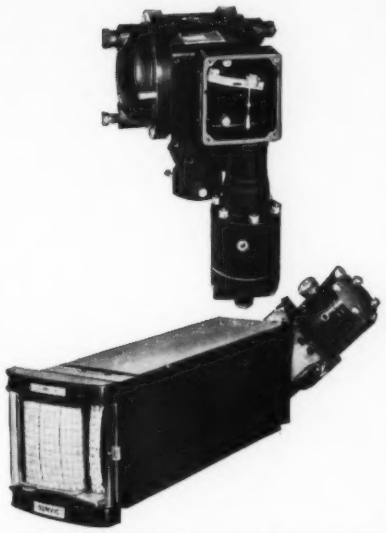
SUNVIC

have a hand in most industrial processes

There are very few industries indeed in which there are not, somewhere, processes controlled by Sunvic instruments .... either pneumatic, electronic, electrical or electro-thermal. Sunvic activities range from graphic panels and integrated measurement/control systems to components for numerous industrial purposes, from complete reactor instrumentation to equipment for science and research.

This is part of a unit for scanning pneumatic signals in Sunvic automatic data handling equipment.

Pneumatics



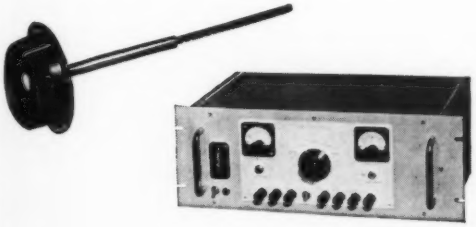
Differential Pressure Transmitters: withstand full body rating overload in either direction; standard differential ranges 0-20 to 0-400 inches w.g. Safe working pressure up to 6,000 p.s.i. (forged steel). Ambient temperature limits −32°C to +94°C. Up to 800% zero suppression.

Recording Control Station: available as single or duplex recorder or as control station with auto/manual switching. Chassis completely removable without tools leaving process on control. Detachable, interchangeable chart drive. All zero adjustments from front.

Components and electronic instruments

Adjustable Bi-metal Thermostats can control temperatures up to 300°C. Stem lengths up to 22″: adjustment ranges up to 250°C. Normally closed or normally open contacts.

D.C. Amplifier: high stability and linearity make this ideal when measuring/recording thermocouple or straingauge output. Ranges: 0.1mV to 100mV; zero stability ±.001mV over 1,000 hours at 1mV range.



Complete systems

This is one unit from an automatic data handling installation monitoring over 2,000 points measuring temperature, voltage, current, etc. Besides automatically printing out a consolidated log sheet of all readings the equipment gives warning if any point exceeds pre-set maximum or minimum values.

Send for details

of Sunvic pneumatics, components or data processing to:

SUNVIC CONTROLS LTD
P.O. BOX 1, HARLOW, ESSEX
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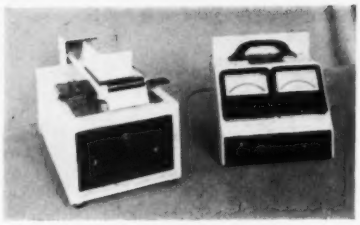


Personnel protection densitometer

controlled light source and a vacuum photo-electric cell with a d.c. amplifier.

The light unit is fed from a constant voltage transformer and has a coarse and a fine rheostat fitted for the control of level of illumination. The measuring table is of sufficient area to enable also large X-ray plates to be measured. The standard instrument is fitted with two viewing apertures, one $\frac{3}{16}$ in. in diameter and the other $\frac{1}{16}$ in. in diameter. With the large aperture, densities up to 6 can be easily read.

The output from the photo-cell is fed into a highly stable d.c. amplifier fitted with two inter-calibrated meters, one scaled to read over the density range zero to 2·0 and the other scaled to read zero to 0·5. A switch is provided to enable the user to change from one meter to the other. The d.c. amplifier is fitted with a range switch, which extends the scale of the standard meter by a factor of 3, thus leading to higher reading accuracy on high density.

The instrument is portable and easy to use, which renders it suitable for semi-skilled operators.

Circle **46A** *for further details.*

Automatic Impulse Heat Sealer

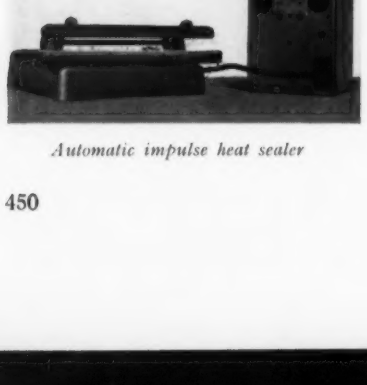
MANIFOLD MACHINERY CO. LTD. announce the introduction of their new automatic impulse heat sealer.

It will seal polythene, melinex, nylon (for surgical purposes), p.v.c. and coated papers to other materials.

The standard model, as will be seen in the illustration, has 16 in. jaws that are covered with a special tape which ensures that no sticking or burning at the edges of the material being sealed takes place.

It is capable of sealing material up to 0·050 in. thickness (e.g., two thicknesses of 0·025 in.), can be operated in any position, and gives outputs up to 1,200 seals per hour according to the type of material being handled.

The automatic control unit, which is seen on the right of the illustration, has three dials mounted on the panel.



Automatic impulse heat sealer

The centre dial controls temperature of weld, the right-hand dial controls heating time of weld and that on the left controls cooling time of weld.

Standard electrical specification caters for 220/250 volts, 50 cycles, single phase, and no special fitments are required apart from the normal 5 amp, 3-pin socket mains supply.

Operation is simple, just switch on, insert the material and press the foot switch—the complete cycle will then automatically take place irrespective of the amount of time that the foot switch is held down.

This impulse heat sealer can be used for the packaging of powders, granulated materials, liquids or solids.

A reel carrier attachment is available as an extra and can be added or taken off as required. It will be found most useful for the small quantity making of bags from layflat or gusseted tubing or where small sampling runs are needed.

Circle **47A** *for further details.*

Moisture alarm

Moisture Alarm

ON this moisture alarm the wet and dry limits of any material are set on the dial which will then light a lamp, ring a bell, or alter controls when the moisture alters beyond the required limits.

The alarm indicates the amount of moisture by means of the dial reading, and the two adjustable pointers coloured red and green are initially set to the desired control points by two external screws on the dial.

An external electrode is used and this makes a moisture measurement by means of a dielectric measurement at a frequency of 100 megacycles.

Specification

Transistor operated. Alarm or control switching 15 amp, 250 volts. Stable automatic indication, no checking or adjusting. Moisture indication by moving-coil meter. Mains operated 200-250 volts, 50 cycles. Fully stabilised for 200-250 volts. No mains tapping. One year unconditional guarantee. Delivery from stock.

Circle **48A** *for further details.*

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Scottish Nitroglycerine Plant

THE second Biazzi nitroglycerine plant at I.C.I. Nobel Division works at Ardeer went into operation under complete remote control recently and is now working effectively and successfully. Work has been undertaken at Ardeer over the past few years on automatic operation of plant and the first Biazzi unit went into operation under remote control some time ago. Training of staff on remote control methods was undertaken, based on the experience gained on the initial unit. The plant was shut down and converted to remote control and put into operation on this basis recently. The remote control room is constructed of reinforced concrete and protected from the process room by a special mound. A large stainless steel instrumentation panel carries the indicators and gauges showing the stage of processing and a control desk is fitted with levers. This is similar to the equipment previously used and adjustments are made by movement of the appropriate control lever on the control desk guided by the data offered by the instrumentation panel. The equipment is broadly similar to that already in use for over a year in the first Ardeer Biazzi plant which was the first in the world to go on to remote control. Some changes have been made, mainly covering the method of direct viewing of the process room. In the older plant direct television viewing is used to transmit pictures by closed circuit to the control room. In the new layout a high-grade optical system of mirrors and lenses allows the remote control room operatives to view the stainless steel separating vessel and other essential points in the nitrating room. This gives a first-class visual inspection system.

Hole in Heart diagnosed on Standard Industrial Recorder

In a small operating theatre at the National Heart Hospital, London, a patient can now be rapidly examined for a variety of heart defects by a new system of investigation using an industrial strip chart recorder.

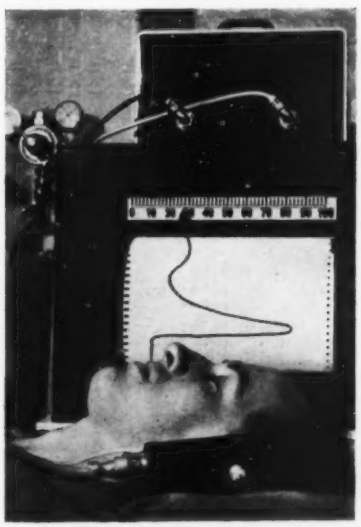
The recorder is used to record continuously the concentration of injected dye as it circulates through the bloodstream. As well as providing a measure of cardiac output in litres per minute, the curves on the recorder, which is supplied by Honeywell Controls Ltd., give specialists vital information at a glance.

A shot of dye is injected into the patient's arm, and carried round the bloodstream until it becomes so diluted that the dye concentration reaches a uniform low level. During this dilution process, which lasts for about 12 seconds, the dye concentration in the blood is continuously monitored. This is done by fitting an assembly, specially designed by Mr. J. Norman, of the Institute of Cardiology, across the lobe of the patient's ear. This unit passes a beam of filtered light through the lobe to a photo-electric cell. Variations in the quantity of dye present in the arterial blood passing through the ear cause changes in the output voltage of the cell. This voltage is fed directly to the high-speed recorder.

When a quantitive analysis is required, the same principle of measurement is used, but the earpiece is replaced by a cuvette, which draws arterial blood from the upper arm, through a transparent tube. Blood passing through the tube is monitored, as before, by a photo-electric assembly mounted at a convenient point, and the cell voltage fed to the recorder.

About seven seconds after the injection, a wave-front of high dye concentration passes the measuring point, and causes a sudden large rise in the recorder reading. This dies away rapidly, and is followed by a second smaller peak when the wave-front, now much diluted, passes through the ear for a second time. The dye concentration then decreases slowly to a low constant value. This sequence of events provides a characteristic and instantly recognisable normal curve on the chart and abnormalities show equally characteristic curves.

As the success of the test depends on tracing a fast-changing variable over a period of a few seconds, the emphasis in the measuring system is on accuracy and speed of response without overshoot. The high-speed recorder, which operates on the continuous balance potentiometer principle, is designed to register full-scale travel (one millivolt) in one second. A special amplifier gives the motor speed necessary for fast pen-travel, and overshoot is reduced by an adjustable damping circuit.



Chambers of the heart revealed by industrial strip chart recorder

Circle 58 for further information

NOW—a moving coil relay for tough industrial use

MOVING COIL RELAY Type SB2

This robustly made relay will stand up to the wear and tear of industrial use. It is proof from damage by shock or vibration and the floating bearings ensure long life and reliability. The powerful coil movement gives a high contact pressure and the contacts themselves, gold mating on platinum, can be adjusted from outside over the whole scale.

Proof voltage between contacts, coil frame and earth—500 V.A.C. Maximum contact voltage 30 v. Insulation resistance: 10,000 MΩ min. between contacts, coil frame and earth.

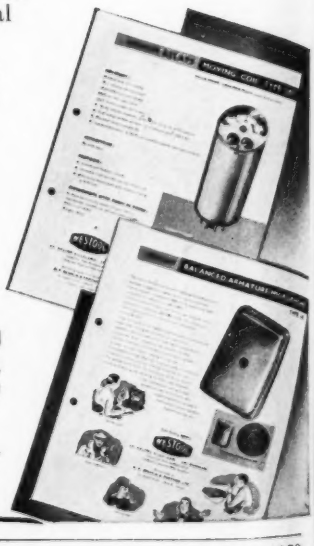
Photograph showing actual size.

and a balanced armature miniature microphone that's 'MADE IN GT. BRITAIN'

MICROPHONE Type LE

This microphone incorporates the design and manufacturing skill that is characteristic of all Besson micro-components. And the financial advantages over imported microphones are obvious.

The Type LE. Microphone is designed to operate with transistor amplifiers and will match into the average transistor which may have a resistance of 1,500—3,000 ohms. The microphone impedance is 3,000 ohms measured at 1,000 cycles and the resistance is 360 ohms. It is made to operate within a temperature range of 20 to 115°F, but can be specially treated to operate at much higher temperatures if required.



Send for technical leaflets to the SOLE SELLING AGENTS:

WESTOOL LIMITED

ST. HELEN'S AUCKLAND, CO. DURHAM

Phone: West Auckland 551/5. Grams: Solenoid, West Auckland.

Birmingham Office: 7 Newhall Street, Birmingham 3. *Phone: Central 3901*

Manufactured by: A. P. BESSON & PARTNER LTD., St. Josephs Close, Hove 4, Sussex.

TIB 114

NEWS OF THE INDUSTRY

New British Contribution to Atomic Energy Research

EXPECTED to play an important part in the future of atomic energy research, the nuclear instrumentation for the largest and most advanced reactor which Britain has exported to any European country was inspected recently by His Excellency, the Danish Ambassador, at the Southend-on-Sea Works of Ekco Electronics Ltd. Destined for the highly-developed D.R.3 reactor, now under construction at Riso, in Denmark, this complex equipment has been completed ahead of schedule and will now be dismantled for shipping to Denmark, where it will be commissioned later this year.

Unlike a power-producing reactor, a materials-testing reactor serves as a highly-complex test bed for atomic engineering experiments. Its instrumentation acts like a brain to keep a rigid control over the behaviour of the reactor, under widely varying conditions of operation. A complicated system of interlocking electrical circuits takes precautions against the possibility of human errors, exercising considerable control over personnel engaged in the many kinds of research for which the reactor is designed.

The Riso reactor is the third of its kind to be built. Experience gained by Ekco in the development of the nuclear instrumentation for the two previous examples in this country and a somewhat similar type in Australia has allowed the inclusion of many detail improvements.

Ekco engineers will commission the nuclear instrumentation in Denmark, in co-operation with Head Wrightson Processes Ltd., the contractors responsible for the reactor.

Simmonds Aerocessories Ltd. Form a Belgian Subsidiary

SIMMONDS AEROCESSORIES LTD., a member of the Firth Cleveland Group, announce the formation in Belgium of Simmonds Aerocessories (Belgium) S.A. as a subsidiary company.

The new company has offices at 25 rue Faider, not far from the centre of Brussels. The manager of this company is Mr. George Harms, and the company will handle Simmonds self-locking nuts, Spire speed nuts, and the products of Firth Cleveland Instruments Ltd.

Research Station for Scotland

A RESEARCH station to study the effects of the aurora on radio reception is to be set up on the site of a former radar station at Hillhead near Fraserburgh in Aberdeenshire.

This research, part of a programme of ionospheric studies, will be undertaken by the Stanford Research Institute of America in collaboration with scientists from the Royal Radar Establishment of the Ministry of Supply. Observations will be made with a large parabolic reflector about 140 feet in diameter, brought from America. The experiments are expected to start in the late spring or early summer and will last one or two years. The cost will be borne by the Americans.

The Aberdeenshire site has been chosen because of its geographical suitability for the study of aurora phenomena. There will be no radiation danger and interference with radio and television will be prevented by the operating conditions laid down for the installation. There should be no restrictions on agricultural work except that the vicinity of the installation must be protected from damage by livestock.

Southern Instruments Limited

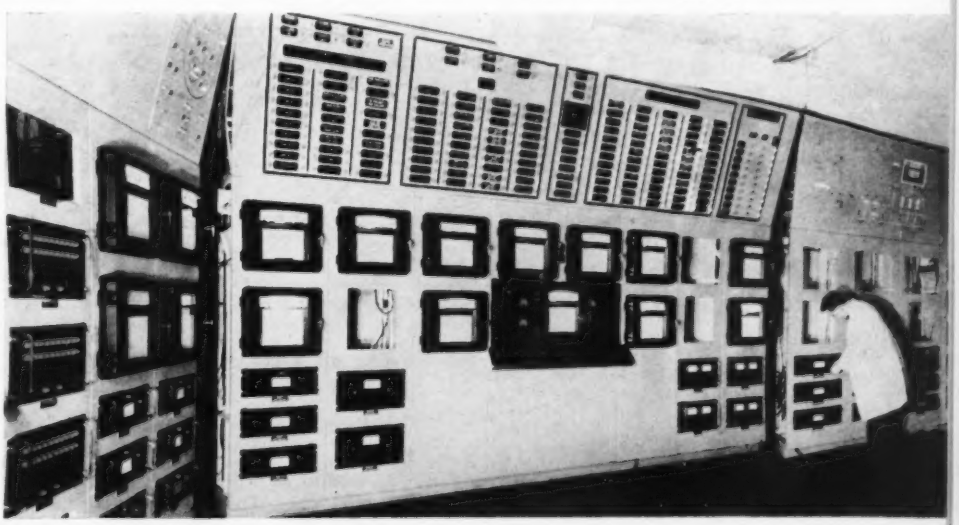
SOUTHERN INSTRUMENTS announce the formation of an Analytical Instruments Department which will sell equipment designed and manufactured within the company, and also sell, and in some cases manufacture, equipment of outside design.

Further developments will follow in the polarographic field. Other analytical electronic tools will become available in the future, the first of which is the Sigrist and Weiss (Zurich) photometer, suitable for both laboratory and industrial measurement of absorption and turbidity.

Mr. W. B. Horner, formerly sales manager of the company, has been appointed general manager of the Analytical Department, and will be assisted by Mr. G. B. Thorpe, B.Sc., late of Plessey, on technical sales, and by Mr. J. Hetman, A.R.I.C., on applications research.

"A Survey of Measuring Weirs in Open Channels"

DR. F. V. A. ENGEL and Mr. W. Stainsby, respectively consultant and manager of the Technical Department of Electroflo Meters Co. Ltd., presented a paper to the Institution of Civil Engineers, entitled: "Velocity-of-Approach Factors in Unified Weir Equations". This paper was published in the *Proceedings of the Institution*



Final adjustment of part of the instrumentation system for the new Danish materials-testing reactor D.R.3

of Civil Engineers, **9**, pp. 165-179, and written discussion on this paper was published in **10**, pp. 580-590.

The measurement of flow of water by the use of weirs is a very large subject, and it was not possible for a complete treatment to be given within the limitation of space allowed by the Institution. A more comprehensive survey of the subject, including the work presented to the Institution of Civil Engineers, was made by the authors, and was the subject of a series of five articles published in *Water and Water Engineering* from April to August, 1958, inclusive. These articles have been reprinted and bound in a single publication under the above title and copies are obtainable from Electroflo Meters Co. Ltd., Abbey Road, Park Royal, N.W.10.

Electroflo Meters' fluid dynamics laboratory is now in the course of expansion, and in a few months' time its services will be available generally to industrialists for an analysis of their fluid flow problems (on a confidential basis).

Hilger & Watts, German Branch

HILGER & WATTS LTD. announce the opening of a branch office in Western Germany at Witten near Dortmund. This follows upon the expansion of Hilger and Watts' business in Western Germany and in the Ruhr in particular.

Racal Instruments Ltd.

THE Instrument Division recently announced by Racal Engineering Limited has been formed into a new company, namely, Racal Instruments Limited, which will give far greater scope for the production and development of present instruments and new lines to be marketed shortly.

Mr. J. H. Head, late of Advance Components Limited, has joined the board of this new company as director and general manager.

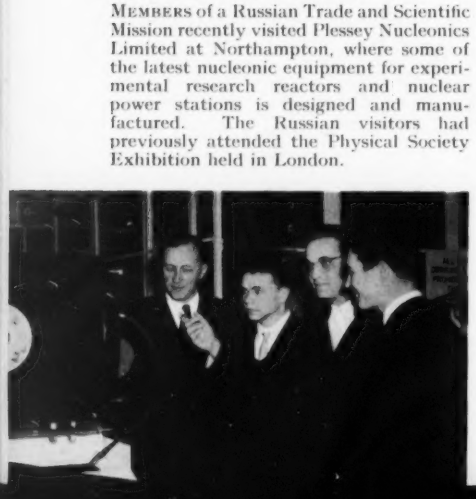
Tecalemit—British Filters

TECALEMIT LIMITED have recently purchased half of the ordinary shares in British Filters Limited, of Maidenhead.

Mr. S. G. Gates, C.B.E., chairman, and Mr. P. R. Scutt, managing director of Tecalemit Limited, will join the board of British Filters. Mr. T. E. Worth, B.A., M.I.Mech.E., present chairman and technical director, will continue in that capacity, together with Mr. Nigel J. Bennett, D.F.C., A.C.A., who will continue as managing director.

Russian Scientists Visit Britain

MEMBERS of a Russian Trade and Scientific Mission recently visited Plessey Nucleonics Limited at Northampton, where some of the latest nucleonic equipment for experimental research reactors and nuclear power stations is designed and manufactured. The Russian visitors had previously attended the Physical Society Exhibition held in London.



Mr. P. F. Lewer, of Plessey Nucleonics Ltd. (third left), explaining the workings of a precipitator which is used with the Plessey burst slug detection system to Mr. Khrustalef (first left), Mr. V. S. Andreev (second left) and Mr. Khanzhenkov (far right)

Euratom Commission Visit

MEMBERS of the Euratom Commission recently visited Berkeley Power Station. The photograph shows Mr. Lombard, chief site construction engineer, talking to members of the Commission, who were led by Mr. De Groote who can be seen here, third from the left in the front row.

Metro-Vick Activities During 1958

Two new instruments have been added to the standard range. These are the Type SN rotary synchroscope and the Type DN2 circular scale permanent magnet moving coil ammeters and voltmeters. Development work on meters generally has resulted in the Types NF3 and NF4 polyphase meters being available in switchboard pattern cases. In the field of relays, developments and improvements have been made in relays for motor and generator protection and in over and/or under-frequency sensitive relays.

The Metrovick 950 general-purpose digital computer incorporating junction transistors is now available, and the Metrovick 1010 transistorised data processing system should be available by the end of 1959.

Nuclear instrumentation for three Merlin-type research reactors has been completed by Sunvic. The equipment includes control desks, control panels, plant equipment, ion chambers, beam tube indicators, fisson production protection panels and primary plant instrumentation.

Electron microscopes of the EM6 type are now in full production. The places they have so far been installed at include the Royal College of Surgeons, London, and the National Research Council, Canada.

New mass spectrometers have been introduced. These include an instrument for the analysis of compounds having high molecular weight (up to 700), and an instrument designed for the isotopic analysis of both solids and gases.

Development of a new instrument, the X-ray microanalyser, is progressing. This instrument enables quantitative analysis to be carried out on small volumes of about 1 cubic micron of material.

Hilger & Watts—Engis Equipment Co.

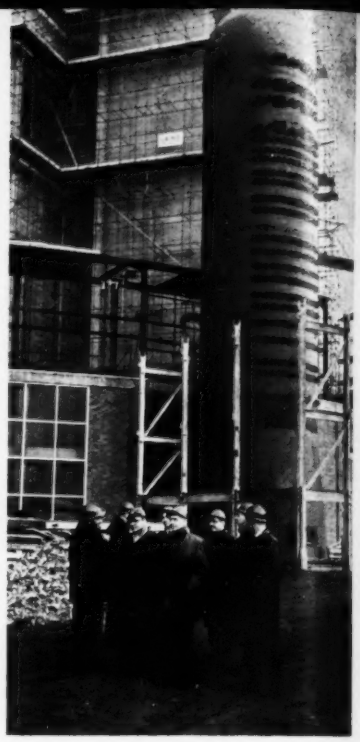
HILGER & WATTS LTD. announce the formation of an affiliated U.S.A. company —Hilger & Watts Inc., in association with Engis Equipment Co. The reason is the increased volume of the company's sales in North America.

Specialised Brazing

NEWTON VICTOR LTD., the X-ray Department of Metropolitan-Vickers Electrical Co. Ltd., has recently introduced a new service to industry—specialised brazing.

The plant provides for the high quality brazing of components in controlled atmospheres and under vacuum. It includes radiation and muffle furnaces, with which temperatures up to about 1,800°C can be achieved, so that no torch or flame is needed; these furnaces will handle parts up to approximately 3½ in. square and up to 10 in. in length. There are also "eddy current" furnaces, which give fairly local heating and temperatures in excess of 1,100°C, and which are suitable for the brazing of circular components; these will deal with items up to 3½ in. in diameter and up to 3 ft 6 in. in length.

The joints catered for include stainless steel to stainless steel; stainless steel to steel; copper to steel; steel to steel; copper to copper; steel to Nilo K; and Monel to other metals. A method of brazing beryllium has also been developed, and applications for tungsten brazing can be investigated.



Euratom Commission visitors at Berkeley Power Station

Printed Circuits' Information Service

PRINTED CIRCUITS LTD., of Borehamwood, Herts., manufacturers of copper etched wiring circuits, who recently became associated with The London Electric Wire Co. & Smiths Limited, are about to establish an information service in the form of a series of technical bulletins, to provide present and potential users with the latest information on production techniques and recent applications. Those wishing to receive these brochures are asked to write stating their interest and copies will be sent immediately on publication.

New London Showroom and Office

A. A. JONES & SHIPMAN LTD. announce the opening of a new London showroom and office which will provide demonstration facilities, after sales service and technical service.

IBM World Trade Laboratories (Great Britain) Limited

IBM World Trade Laboratories Corporation announces the formation of a British subsidiary company, IBM World Trade Laboratories (Great Britain) Limited.

Mr. W. S. Elliott, M.A., M.I.E.E., F.Inst.P., has been appointed managing director of the laboratories which are at present situated at Hursley House, near Winchester in Hampshire. Plans are in hand for the erection of a new laboratory in the Southampton area.

The laboratories are undertaking research and development primarily in the field of electronic data processing and computing, and have several major projects in hand.

Three Crompton Films on Circuit to Interested Associations

CROMPTON PARKINSON have produced three colour films on their rotating plant, cable and switchgear products.

In the rotating plant film, "Driving Force" tells all the why's and wherefore's on motors—from small fractionals in the home to rotating plant for locomotives. In twenty minutes this film shows how the various classes of motors are designed, made and tested, and how they are used.

In "Mile after Mile", the cable film which has a running time of ten minutes, the work that goes into the making of all types of cable is illustrated, from raw material to finished testing. An animated montage sequence illustrates how the cables are used in the home, for distribution and for specialist applications such as welding cables, ship-wiring and coal mining, etc.

"Controlling Link", the switchgear film, starts with a bang as a metalclad, air-insulated switch unit is tested to destruction at the A.S.T.A. Testing Station at Chelmsford. An animated sequence then shows how switchgear is used to protect the various stages in power distribution, from the power station to the domestic consumers' sub-station. How switchgear is designed and manufactured follows.

These films, "Driving Force", "Mile after Mile", and "Controlling Link", are available, including "Strictly Instrumental" which has been reviewed previously, to schools, technical colleges, and engineering societies, etc., for showing on 16 mm sound equipment.

New Laboratory for Star Aluminium

As part of their big expansion programme, the Star Aluminium Company recently announced the opening of a new 4-storey foil development laboratory at Wolverhampton.

Its purpose, among other things, will be to experiment, develop and promote new uses of aluminium foil for the domestic and industrial markets.

Dowty Rotol Deal

THE DOWTY GROUP announced the following preliminary details of how they propose to raise £3,500,000 to pay for their intended acquisition of Rotol, largest propeller manufacturer in the U.K.

They plan to offer shareholders 2,400,000 new ten shilling shares as a rights issue of one new share for every two shares held, the price to be decided later. The group's authorised capital is to be increased by one million pounds to four million pounds. C.I.C. permission has been obtained for these proposals.

British Electronics at the Hanover Trade Fair

FOLLOWING on the successful experience of the group of British electronic manufacturing companies at the German Industries Fair in Hanover last year, Electronic Components Centre (Great Britain) Ltd., the organisers of the group, are now actively planning for the 1959 Fair.

The company reports that their members were very pleased with the response from the German and other European buyers who visited them. Much valuable experience has been obtained from this first year's exhibition. A number of member companies have arranged follow-up tours for their sales executives in collaboration with their agents. Others, who were not previously represented, have been able to avail themselves of the services of the German Agents' Association in selecting suitable representatives.

Due to the special arrangements made with the German Fair organisers, Electronic Components Centre are able, if they wish, to show the products of a different group of manufacturers each year, thus presenting a varying cross-section of the British electronics industry. They have been fortunate in having been assigned a commanding position, covering an area of 2,000 square feet, on the first floor of the newly constructed building reserved for the radio and electronics industry. Their stand is situated on a main gangway, and adjoins the official exhibit of the German Post Office. Their member companies enjoy all the advantages of display on a large stand with first rate facilities for the entertainment of their guests at a cost not greater than that for an individual stand surrounded by those of foreign concerns.

Such is the interest in this Fair of electrical and electronic firms that all the space in the two new buildings erected in 1957 has been taken on 10-year contracts.

International Convention on Transistors and Associated Semiconductor Devices—21st-27th May, 1959

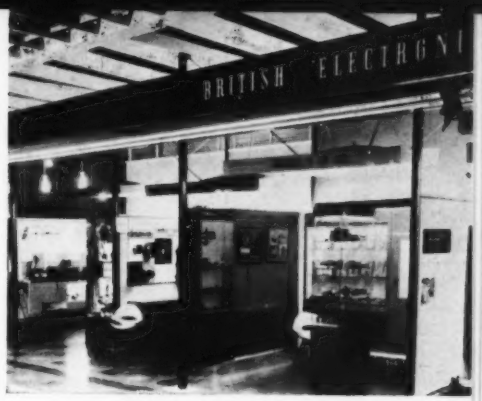
THE INSTITUTION OF ELECTRICAL ENGINEERS is very pleased to announce that the Rt. Hon. the Viscount Hailsham, Q.C., Lord President of the Council, has accepted an invitation to deliver the opening address at the International Convention on Transistors and Associated Semiconductor Devices which is to be held at Earl's Court during the period 21st-27th May, 1959.

Air Conditioning for Electronic Telephone Laboratories

FULLY automatic air conditioning is a feature of the new laboratory recently constructed by the Ericsson Telephone Co. Ltd., at Beeston, Nottingham. This laboratory has been designed to develop complicated electronic equipment in the overall exchange development.

The air conditioning, designed and installed by Norris Warming Co. Ltd., will maintain an even temperature, despite the emission of a great deal of random electrical heat.

The air conditioning plant consists of a main supply fan, drawing the fresh air in through filters, and discharging cooled, filtered and humidified air into the occupied spaces through air diffusers set in the ceilings. The vitiated air is passed through grilles into the corridors, and extracted via a main extract fan, and passed to atmosphere or re-circulated through the main intake plant, as the atmospheric conditions warrant.



British Electronics at Hanover Trade Fair

The local test cabinets are separately dealt with through a number of local supply fan and extract units, to avoid the concentrated heat emitted by these cabinets from upsetting the balance of the main air conditioning scheme. The cooling of the air is accomplished by means of spraying chilled water into the main stream. Water is obtained from deep Artesian wells on the site, at 52°F, and is passed through a York Shipley 16 cylinder freon 22 refrigeration cooler. This machine is one of the largest reciprocating packaged units in the country, and is driven by 170 h.p. direct coupled electric motor.

The whole of the equipment is fully controlled, and is capable of operating summer and winter, completely automatically. The refrigeration plant operates as required, by hydraulic automatic valve gear, and the various motorised air supply dampers operate mechanically.

The building has been divided into five separate zones, each of which is individually electronically controlled from thermostats placed in the conditioned rooms, so that as the position of the sun or other heat sources varies during the day, the plant adjusts itself automatically.

Electrical Instrument Test Service

THE BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION announce the establishment of an electrical instrument test service at their laboratories in Chislehurst, Kent. Although originally set up at the request of members of the Association, the service is now available to other firms and organisations.

Operated under the supervision of the National Physical Laboratory and using N.P.L. certified equipment, the department will test and issue certificates for instruments up to precision grade accuracy. Calibration of d.c. meters between 1 mV and 500 V and between 2 μA and 2 A can be undertaken immediately. In the near future the latter range is to be extended up to 25 A, and the calibration of a.c. instruments over the ranges 1 V to 500 V and 10 mA to 25 A will be undertaken. Charges for the service will be appreciably less than the cost of N.P.L. certification.

It is expected that this service will be welcomed by both manufacturers and users of instruments in this country, particularly where an independent test certificate for an instrument is required but where the prestige value of an N.P.L. certificate is unnecessary.

Further information may be obtained from The Director of Research, The British Scientific Instrument Research Association, South Hill, Chislehurst, Kent.

International Congress on Electro-Heat

NINETEEN papers by British authors are to be presented at the fourth International Congress on Electro-Heat to be held at Stresa, Italy, from 25th to 29th May. Altogether 199 papers will be given to the ten sections into which the Congress will be divided. The number of delegates notified at the end of 1958 was 580, of whom 39 are British.

Following are the titles of the British papers and the names of the authors:—

"Electricity in the Pottery Industry" by Messrs. H. A. P. Cadell, M.A., M.I.E.E., and S. Scholefield, A.M.I.E.E., Midlands Electricity Board.

"Selling Electro-Heat" by Mr. H. Jackson, B.Sc., M.I.E.E., M.I.Mech.E., South Wales Electricity Board.

"Development of Electric Radiant Heating Tubes" by Mr. L. W. Webb, Birlec Ltd.

"Development of Electric Smelting in the British Commonwealth" by Dr. A. G. Robiette, D.Sc., F.I.M., Birlec Ltd.

"Electric Surface Heating for Industry" by Mr. H. Reik, M.Sc.(Eng.), M.I.E.E., M.I.Mech.E., Isopad Ltd.

"Electro-Heat in the Fabrication of Aluminium" by Mr. A. J. Jones, B.Sc. (Eng.), A.M.I.E.E., Northern Aluminium Co. Ltd.

"The Control of Large Electric Arc Furnaces in Relation to their Effect on the Supply System" by Mr. J. W. S. Payne, B.Sc., A.C.G.I., British Thomson-Houston Co. Ltd.

"Vacuum Induction Melting and Casting" by Mr. F. L. Gladwin, Wild-Barfield Electric Furnaces Ltd.

"Induction Melting Furnaces" by Mr. A. G. Allen, Birlec Ltd.

"Radio Frequency Heating as applied to the Wood Industry" by Mr. J. Pound, Pye Ltd.

"Some Observations on the Design and Operation of an All-Electric Glass Melting Furnace" by Mr. P. A. M. Gell, Elemelt Ltd.

"High Speed Cinematography of Sustained Power Arcs" by Mr. J. C. Needham, B.Sc., Electrical Research Association.

"Industrial Storage Space Heating" by Mr. J. W. Moule, B.Sc.(Eng.), M.I.E.E., South of Scotland Electricity Board.

"Interstage Annealing with M.F. Induction Heating" by Mr. K. A. Zandstra, A.M.I.E.E., Philips Electrical Ltd.

"Developments in Resistance-Heated Vacuum Furnaces" by Mr. M. Donovan, General Electric Co. Ltd.

"Applications of Infra-red Heating in the Plastics, Rubber and Textile Industries" by Mr. G. M. Hogarth, General Electric Co. Ltd.

"Electricity Supplies to Large Electric Arc Furnaces; Some Technical and Economic Considerations" by Mr. A. Haddock, B.Sc., M.I.E.E., Yorkshire Electricity Board.

"Electrode Boilers for Industrial Electric Heating" by Mr. S. A. Williams, A.M.I.H.V.E., Bastian & Allen Ltd.

"A Mains Frequency Induction Holding Furnace for Gravity and Low Pressure Die Casting" by Messrs. M. Gibbs and R. H. Barfield, Wild-Barfield Electric Furnaces Ltd., and Mr. E. C. Lewis, Alumasc Ltd.

Anyone interested in the Congress can obtain further information and a delegate's registration form from The Secretary, "The British National Committee on Electro-Heat", 2 Savoy Hill, London, W.C.2.

The British National Committee on Electro-Heat was re-organised about a year ago and its members now are:—

British Electrical and Allied Manufacturers' Association, British Electrical Development Association, British Iron & Steel Research Association, British Non-Ferrous Metals Research Association, Department of Scientific and Industrial Research, Electrical Research Association, Electricity Supply Industry (through the Electricity Council, Electricity Boards and the South of Scotland Electricity Board), Institute of Metals, Institution of Electrical Engineers, Iron & Steel Institute.

Radioactive Radiation Monitoring Service

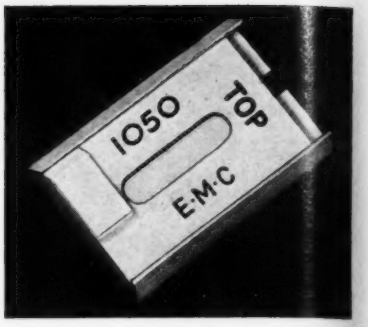
ELECTRONIC MACHINE CO. LTD. have now formed a Radiological Division which is offering a complete radiation monitoring service to users of X-ray machines and other radioactive materials.

The Radiation Monitoring Service will supply a numbered monitoring film holder, together with a film—one spare film being supplied at the same time for replacement at the end of the first week. The number of holders being in accordance with the number of personnel for whom it is desired to contract.

At the end of each week the film is removed from the holder and posted to the Radiation Monitoring Service for processing, reading and recording, the spare film then being put into the holder and a further film replacement is sent by the Service on receipt by them of the first film for processing. Each film holder is numbered, the number being allocated to one individual wearer and it is most important that this is never changed since the number is held throughout the whole of the system on which is recorded the weekly and accumulative dosage of the individual.

In the event of a weekly or accumulative dose exceeding the recommended dosage, as laid down by the International Commission of Radiological Protection, an immediate communication is sent to advise the safety officer or the principal of the organisation concerned so that immediate steps can be taken to remove and give the affected person the necessary treatment and also to take necessary measures to avoid a further occurrence.

The team is available also to advise on safety measures necessary when new installations are being planned or installed and we understand that facilities are being arranged for urine analysis, blood counts and analysis of soil samples, food, etc.



Film holder for monitoring radiation dosage received by personnel

An interesting and informative booklet has been prepared for the convenience of any person or organisation who would like to investigate the possibilities of employing this service and copies will be sent on application to: Radiation Monitoring Service, Electronic Machine Co. Ltd., 41 Lodge Road, West Croydon, Surrey. (Thornton Heath 8206.)

BICC Derby Office Change of Address

THE address of British Insulated Callender's Cables Limited branch office at Derby has been altered to:

Hartington Street,
Derby.

The telephone number remains the same, Derby 41421.

New Company to Make Servo Components

SERVOMEX CONTROLS LIMITED have concluded an agreement with Feedback Limited whereby Servomex will manufacture and market Feedback designs.

The range of equipment includes servomechanism components and assemblies as well as apparatus for servosystem analysis and demonstration.

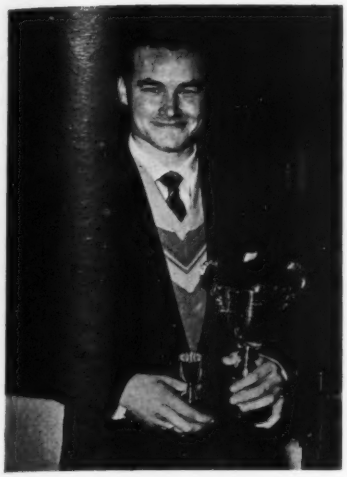
Mr. R. C. Steel, chairman and managing director of Servomex Controls Ltd., has been elected to the board of Feedback Ltd., where he joins: Dr. J. H. Westcott (chairman), Dr. P. F. Blackman, Mr. T. J. Strand (managing directors) and Mr. J. Merrett.

In keeping with their particular interest in the educational field, liaison with colleges in the U.K. will remain the responsibility of Feedback Limited.

Simmonds Aerocessories Ltd.

MR. J. D. WILSON, assistant export sales manager of Simmonds Aerocessories Limited, visited Holland recently. Besides visiting the company's agents in Holland, Messrs. P. L. W. de Ridder & Company, Mr. Wilson also attended the Dutch Motor Show.

Simmonds Aerocessories Ltd., Treforest, Glamorgan, is a member of the Firth Cleveland Group, manufacturing Spire Speed fastenings, Simmonds self-locking nuts, Fram filters and Surform hand tools, as well as a range of mechanical, electrical and electronic instruments. The company's Dutch subsidiary, Simmonds Maatschappij N.V., Amsterdamse Straatweg 13, Naarden, manufactures lock nuts for the Dutch and other adjacent markets.



E. L. Amiss, 1958 winner of the Commander Kent Challenge Cup

Kent Apprentice Prize-giving

MANY months of hard work and endeavour received recognition on Monday, 19th January, when George Kent Ltd. held their Annual Apprentice Prize-giving and Exhibition of Work at Biscot Road Works, Luton.

The meeting was opened and presided over by the company chairman, Commander P. W. Kent, R.N., who also presented the prizes. The Lord Bishop of St. Albans, The Rt. Reverend E. M. Gresford-Jones, D.D., was present as guest speaker and addressed an audience which included representatives of local education, industry and employment, as well as relatives and friends.

Particularly noteworthy were the efforts of E. L. Amiss, 1958 winner of the Commander Kent Challenge Cup, and D. M. Abbott and D. J. Puddefoot, who, on completion of their five years' training, had satisfied the examination requirements of the Institutions of Mechanical Engineers and Electrical Engineers, respectively. These three apprentices were among a total of seven whose names appeared in the Board of Directors' Honours List.

Conference on "The Use of Computers in Production Control"

THE Central London Productivity Association in co-operation with the Northampton College of Advanced Technology sponsored a one-day conference on 2nd April on "The Use of Computers in Production Control". The conference was opened by Dr. M. V. Wilkes, F.R.S., director of the Mathematical Laboratory, Cambridge University.

Change of Title of the Radio and Telecommunication Section of the I.E.E.

BY a decision of the Council on the 5th February, 1959, the name of the Radio and Telecommunication Section of The Institution has been changed to:

"Electronics and Communication Section".

The following circumstances provide the background to this decision.

In recent years the word "Electronics" has been broadly used to cover the evolution of new techniques in fields other than communication and, although the basis of this work may well be attributable to those who have hitherto been regarded as engaged in the radio field, the final applications are often developed by other electrical engineers. Moreover, the incorporation of the word "Electronics" into the name of the Section is intended to emphasise to the profession that The Institution is manifestly the learned society for those properly qualified electrical engineers who regard themselves as "electronic" engineers.

At present, while students deciding to embark on careers as electrical engineers in the heavy current field automatically look to this Institution, there is in the light current field a number who may inadvertently draw an unreal distinction between an electrical engineer and an "electronics" engineer, and who may not appreciate the breadth of the field which is covered by The Institution, and the advantage to the development of the science conferred by a single forum for the discussion of all its aspects.

The word "Radio" no longer appears in the title of the Section, because it is felt that this word, with its modern connotation of certain limited applications, is now insufficiently comprehensive. The continued inclusion within the sphere of the Section of such interests as navigational aid systems and radar is, it is felt, implied in the new title.

So far as the omission of the word "Telecommunication" is concerned, it is considered that the word "Communications" will be interpreted broadly within the context of electrical engineering, and the change makes for a shorter and at the same time a more comprehensive title.

Morgan Crucible Co. Sintered Metal Department Move to New Factory

THE Sales Office has been moved to Wandsworth Works, Point Pleasant, Wandsworth, London, S.W.18, and a new factory and laboratory established there for the production and development of Sinterlink. This combines plant and facilities previously situated at Battersea, and Norton, Worcester.

Owners and Users of Europe's Fastest Computer Attend London Conference

OWNERS and users of the Ferranti Mercury computer assembled in London from all parts of Western Europe to attend a two-day "mutual help" conference recently.

The conference, held at the company's London Computer Centre, was attended by 54 delegates from 22 different organisations.

The emphasis of the conference was mutual discussion after brief introductions by company personnel on topics ranging from user techniques on the first day to new developments and equipments on the second. One particular field of discussion was on the methods of expanding the present common pool of programmes along the lines of the highly successful programme library which exists for users and owners of the company's Pegasus general purpose computer.

This library represents a considerable investment in time, money and experience, valued at over half a million pounds. New users automatically reap the benefit of this investment.

Elliott-Automation

ONE of the subsidiaries of the Elliott-Automation Group, C. P. Clare Ltd., which was formed towards the end of last year to manufacture and sell under licence the products of C. P. Clare & Co., of Chicago, has booked £12,000 worth of orders for its miniature relays in its first full month of operation.

The bulk of the orders are for the Clare 'F' Type relay.

Printed Circuits Ltd. New Service

PRINTED CIRCUITS LTD., who recently became associated with the London Electric Wire Company and Smiths Ltd., announce that the installation of the "Multinex" fully automatic electronically-controlled camera now enables them to offer design engineers a 48-hour service for the production of prototype printed circuits of any size and complexity.

To ensure that users and prospective users of printed circuits are fully conversant with the advantages of printed circuits, a technical consultant service is now in operation and is freely available.

Fully qualified technicians are visiting firms and advising manufacturers in the early stages on the best approach in the use of printed circuits and guiding them in the latest methods of assembly, flow-soldering, etc.

Negretti Sports Pavilion

THE managing director of Negretti and Zambra Limited, Mr. Peter Negretti, realised one of his late father's ambitions recently when he opened the firm's new Sports Pavilion at Stocklake, Aylesbury.

The late chairman and managing director, Mr. Paul Negretti, a keen sportsman, had promised a pavilion to the Sports Club but had been unable to accomplish it in his lifetime.

A large number of employees and their families were present at the opening and a memorial plaque to Mr. Paul Negretti was

Mr. Peter Negretti opening the new pavilion of Negretti and Zambra's Sports and Social Club at Aylesbury

given by members of the Sports and Social Club. The plaque is now exhibited in the pavilion.

EMIAC II Goes on European Tour

As part of its intensive campaign to sell British electronic equipment on the continent, E.M.I. Electronics Ltd. in March started an extensive tour of major European industrial centres to demonstrate its new general-purpose analogue computer EMIAC II.

The tour started in Dusseldorf, and other cities visited included Munich, Milan, Stockholm, Paris and Hanover. Visits to Paris and Hanover coincide with the Hanover Trade Fair and the French Physical Society Exhibition. Mr. Derek Forster is E.M.I.'s representative in charge of tour arrangements.

EMIAC II is a general-purpose analogue computer of great versatility, which is designed to be built-up in module form. It has already been used extensively on nuclear reactor, guided missile, and other simulation problems.

Great feature of EMIAC II is its use of interchangeable 'C' boxes. These enable a simple simulator, for example, to be tailor-made to meet a specific problem at the price of a mass-produced instrument.

Bray Reshape their Sales Division

GEO. BRAY & CO. LTD., of Leeds, manufacturers of gas jets and burners, spray jets, electric heating elements and electroceramics, have recently reorganised their Sales Division.

The reorganised Sales Division is headed by Mr. C. J. Wynne-Williams, the general sales manager. Promoted to the newly-created position of manager of the Technical Sales Department is Mr. Ernest Cawood, well-known in the gas and allied industries for his wide experience in the applications and uses of gas jets and burners. Mr. Peter Harryman continues as manager of the Marketing and Advertising Department.

The company is conducting a programme of training for the home sales team under Mr. R. L. C. Harnden, the field sales manager.

The present sales effort in the European market is being reinforced by the appointment of a permanent Bray representative in Germany, Herr Gunter Engelhardt, operating from Frankfurt.

For the purpose of speedier communication, Brays are now linked with customers throughout Europe by the International Telex System (Telex Leeds 55186).

A special appointment of technical intelligence officer has been created and has been filled by Mr. D. H. S. Sanderson.

E.M.I. Programming Technique for Automatic Die Production

FIRST-CLASS dies can now be produced on milling machines, direct from the drawing, without the use of an external computer.

Special mathematical techniques were devised to provide continuity in 'blending' between the co-ordinates shown on the normal blueprint and produce fully three-dimensional work pieces. As in the other E.M.I. control systems, punched tape feeds instructions into what is in effect a built-in computer which controls the mill.

For a typical medium-sized product, the tape can be programmed in about half the time required to make a wooden prototype. As girl programmers can be employed instead of skilled model-makers, the cost per hour is also greatly reduced. It is found in practice that the machining time, too, is considerably less than by normal methods.

The system ensures a consistent accuracy of $\pm 0{\cdot}002$ in., much greater than could be achieved by the use of wooden models made to an accuracy of $\pm\frac{1}{64}$ in. and subject to subsequent swelling or shrinkage.

Forging, casting and plastic moulding dies can all be produced on machines equipped with the E.M.I. system. Turbine blades, car rear lights and telephones are three examples of the type of articles for which dies can be produced more efficiently.

G.E.C. Transistor Changes

THE G.E.C. Semiconductor Division has increased the maximum junction temperature of its range of audio frequency transistors from 65°C to 85°C.

As a result of this increase, the maximum collector dissipation of the low power transistors GET 103, GET 104, GET 106 and GET 114 is increased to 200 mW at temperatures up to 45°C (formerly 150 mW up to 35°C) and 150 mW up to 55°C (formerly 50 mW)

New ratings for the medium power transistors GET 105, GET 110, GET 115, GET 116 and GET 120 are:—

For the transistor in free air, 440 mW up to 45°C (formerly 330 mW up to 35°C) and 330 mW at 55°C (formerly 110 mW). With the transistor mounted on a 3 in. × 3 in. cooling fin, 800 mW up to 45°C (formerly 600 mW up to 35°C) and 600 mW at 55°C (formerly 200 mW).

British Computer Expert Lectured in Holland

MR. B. L. HART, of the Computer Applications Department of International Computers and Tabulators Ltd., was invited to lecture on "Production Control by Computer" at the University of Delft, Holland, on Friday, 27th February. Mr. Hart's lecture was part of a course which had been organised by the Dutch Research Institute of Scientific Management and was attended by senior management executives from a number of European countries.

"Production control" is an aspect of production management. The term is used to designate a complex of functional activities concerned with the provision of information about:

(a) what is to be produced
(b) how, when and where it is to be produced
(c) how far actual production matches that which was planned
(d) the requirements of stocks of productive items necessary to ensure continuity of production with the necessary financial outlay.

The computer is the ideal instrument for carrying out the multitude of calculations on which such information is based and Mr. Hart's company, I.C.T., has pioneered in one of its own factories what is believed to be the first attempt in the U.K. to apply a computer in this way. Though this production control computer was only installed last summer, its use is already contributing to the more effective deployment of manufacturing resources. It was with his company's experiences in the installation and operation of this control system that Mr. Hart's lecture was concerned.

Scottish Industries Exhibition

THIS comprehensive exhibition of all aspects of Scottish industries will be held this year in Glasgow from 3rd to 19th September. To publicise the exhibition a delegation from the Scottish Council is visiting the United States and Canada and other members of the Exhibition Council of Management will be visiting other countries.

There is a stipulation that everything shown at the exhibition must be made in Scotland, and well over a dozen instrument manufacturers will be represented.

Enquiries about the Exhibition should be sent to the Exhibition Administration Offices, Woodside Terrace, Glasgow, C.3, Scotland, or to any of the United Kingdom commercial representatives overseas.

Electroflo Service Training School

THE ELECTROFLO METERS CO. LTD. opened its training school in October, 1958. Since then 18 mechanics have attended two week courses. Representatives have been accommodated from Messrs. Fisons Limited, Winthrop Laboratories Limited, A. E. Reed Limited and the Central Electricity Generating Board.

During this time, typical industrial instruments for the measurement and control of process variables are discussed, demonstrated, assembled and calibrated, with particular emphasis upon maintenance.

Such was the success during the first three months of the school's existence that the 1959 enrolments are on an increasing scale. Six courses have been planned during the first six months of the year. Service engineers will be attending the school from the Area Gas Boards, Messrs. A. E. Reed, Messrs. Bowaters Limited, Messrs. Colvilles Limited, Messrs. Woodall Duckham Limited, The Electrical Society of Milan, London Airport, I.C.I. Limited, Albright & Wilson Limited and The Scottish Electricity Generating Board.

Nucleonics at Leipzig

I.D.L. will be showing their new scaler Type 1700 and examples of their industrial equipment on the stand of Dominion Export Company at Leipzig Fair. Their sales manager, Mr. E. W. Jones, will be in attendance. This is part of an endeavour to expand business with the countries of Eastern Europe, following the lifting of trade embargoes on many items of nucleonic equipment. The "1700", a universal counting equipment for all types of radioactivity measurement, has been designed with the export market in mind, and special attention has been paid to reliability and absolute simplicity of servicing in the event of any electronic failure.

PERSONALITIES

African Tour

Mr. J. E. C. Bailey, C.B.E., chairman and managing director of Baird and Tatlock (London) Ltd. and Hopkin and Williams Ltd., left the United Kingdom recently for a short tour of Uganda, Kenya, Northern Rhodesia, Southern Rhodesia and South Africa. He visited the companies' branches, agents and representatives in these countries to discuss general matters relating to the export of scientific equipment and chemicals.

While in North Rhodesia, Mr. Bailey visited a new branch of the companies which has recently been opened at Ndola, on the copper belt. The opening of this new branch will facilitate the handling of the increasing volume of orders for the products of the B.T.L. group of companies coming from the area.

BICC Staff Appointment

British Insulated Callender's Cables Limited announce that Mr. C. S. F. Lane has been appointed to the position of regional manager for Australia and New Zealand in the Overseas Organisation in London. He succeeds Mr. R. H. Semple, who has taken up a senior executive post with an associate company in Australia.

Mr. P. Alsop

Mr. Peter Alsop has left E.M.I. Electronics Ltd. where he has been employed during the past three years in an advisory capacity on the application of new techniques and processes, including printed circuitry and resin encapsulating for use in electronic equipment of advanced designs. He has joined Technograph Electronic Products Ltd. and is responsible for the Technical Sales Division in the computer, guided weapons and airborne equipment fields.

Presentation by Mr. P. J. Ellis to Mr. B. T. Dyett

American Joins Board of Westool Ltd.

Mr. Steven P. J. Wood, president of the Warner Electric Brake and Clutch Company of Beloit, Wisconsin, U.S.A., has joined the Board of Westool Limited, St. Helen's Auckland, Co. Durham, who manufacture Warner electro-magnetic clutches and brakes under licence in this country.

Mr. H. E. Drew

The Ministry of Supply announces that Mr. H. E. Drew has been appointed director of Electronics Production (Air) in succession to Mr. R. E. Sainsbury who is attending the 1959 course at the Imperial Defence College.

Plannair Appoint New Sales Engineer

As part of a sales expansion programme inaugurated recently by the opening of their new factory at Leatherhead, Plannair Limited have appointed Mr. H. D. T. Hotblack, A.M.I.Mech.E., sales engineer responsible for special air movement applications in the general engineering field.

Before joining Plannair Ltd., Mr. Hotblack was on the design staff of Balfour Beatty Co. Ltd., and prior to that with Mackness and Shipley and The Walter Kidde Co. Ltd.

Mr. J. Sieger

Mr. Joshua Sieger has been appointed applications engineering consultant to the Electronic Division of the International Engineering Concessionaries Ltd. This division is the sole British agent for a range of U.S. specialised electronic equipment of advanced design. Recent developments marketed by this division include Microdot microminiature coaxial cables and connectors, cam block barrier type connectors, Sperry Reflectoscope for ultrasonic inspection, Moseley X-Y recorders, Sanborn multi-channel recording systems, etc.

Since 1953, Mr. Sieger has practised as a consultant on both sides of the Atlantic.

Presentation to Mr. B. T. Dyett

Mr. B. T. Dyett, F.C.I.S., A.I.A.C., financial director of R. B. Pullin & Co. Ltd., Brentford and associate companies of the Pullin Group, was presented recently with a "21 year service" gold watch by R. B. Pullin's managing director, Mr. Philip J. Ellis, O.B.E.

Mr. S. P. J. Wood

Atomic Energy Appointments

The United Kingdom Atomic Energy Authority have appointed Dr. Nyman Levin to be director of the Authority's Weapons Group. Dr. Levin has been deputy director since he joined the Authority in July, 1958.

Sir William Penney, who has been combining the Authority Membership for Weapons with the post of director of the Weapons Group, will now relinquish the latter post. As recently announced, Sir William will be succeeding Sir John Cockcroft as Member for Research when Sir John takes up his Mastership of Churchill College.

Dr. Levin is succeeded as deputy director of the Weapons Group by Mr. E. F. Newley.

Hivac Ltd. Appointment

Mr. J. R. Hughes, A.M.I.E.E., M.Brit.I.R.E., has been appointed a director and commercial manager of Hivac Limited, a member of the Automatic Telephone & Electric Group. Mr. Hughes has been with Hivac, latterly as chief commercial engineer, for some eleven years. He was formerly technical secretary with the British Radio Valve Manufacturers' Association.

Preformations Limited Appoint General Manager

Mr. R. W. Stobbs, F.R.I.C., F.I.M., has been appointed general manager of Preformations Limited, Cheney Manor, Swindon, the company recently formed by The Plessey Company Limited and the Arnold Engineering Company, of Illinois, for the manufacture of "Magloy" permanent magnets.

Mr. Stobbs joined The Plessey Company

Circle 59 for further information

Cambridge

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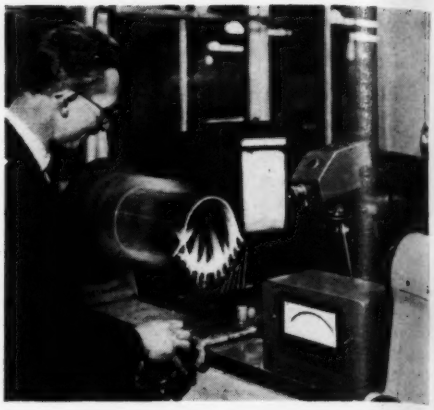

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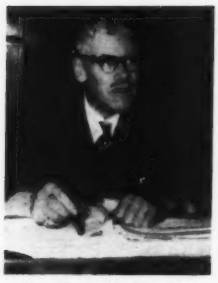
Mr. J. E. Taylor



Mr. E. J. H. Hewetson

Mr. J. F. Willsher

Mr. J. Sim

Limited five years ago as principal metallurgist at the company's Ilford factory. Previously he was for three years chief research metallurgist with the Foundry Division of David Brown Industries Limited, before which he was with Ford Motor Company Limited as a metallurgist.

Mr. Stobbs has addressed many scientific societies on a variety of chemical and metallurgical subjects, both in this country and in the U.S.A.

Marconi Representative in Delhi

Marconi Instruments Ltd. announce that Mr. J. E. Taylor, a technical sales engineer of the Commercial Department, has been seconded to the company's agents in India, Associated Instrument Manufacturers (India) Private Ltd.

Mr. Taylor will assist in the setting up and operating of a Calibration Centre in Delhi, which, equipped with a wide range of instruments, will provide up-to-date facilities for users of telecommunication measurement equipment in India. Marconi Instruments are providing approximately £5,000 worth of their equipment for the Calibration Centre, including signal generators, valve voltmeters, oscilloscopes, and frequency measuring apparatus.

Mr. Taylor, who recently returned to England after spending some time with Marconi Instruments' U.S.A. Office, left for Delhi on 7th February.

Sir John Dean

British Insulated Callender's Cables Limited announce that Sir John Dean, B.Sc., A.R.I.C., F.I.R.I., has been appointed a director of the company as from 9th February, 1959.

New Manager at W. J. Furse & Co. Ltd.

Mr. James D. Furse, 40, has been appointed manager of the Refrigeration Department of W. J. Furse & Co. Limited, Nottingham (member of the E.V. Industrials Group), following the death, in a road accident, of the previous manager, Mr. John French.

Mr. James Furse joined the company as a contracts engineer in 1948 and was chief contracts engineer before taking up his present appointment. He is a graduate of the Institute of Electrical Engineers and served an apprenticeship at B.T.H. (Rugby).

Agency Appointment for "Staffa" Hydraulic Equipment

The Hydraulic Equipment section of Chamberlain Industries Limited, of Staffa Works, Staffa Road, Leyton, London, E.10, reports that it has recently appointed Mr. E. J. H. Hewetson, M.I.Mech.E., to represent its hydraulic activities in the Yorkshire area.

Mr. Hewetson can be contacted at 9 Roger Drive, Sandal, Wakefield (telephone Wakefield 5514) and will advise on any problem of a hydraulic nature.

Mr. W. J. Picken

The English Electric Valve Company Ltd. announces the death at the age of 72, on 24th February, of Mr. W. J. Picken, O.B.E., M.I.E.E.

After a short period of retirement he joined the English Electric Valve Co. Ltd. in July, 1953, in the capacity of technical consultant.

Mr. Picken was for many years a member of the Technical Committee of the British Valve Manufacturers' Association, he became a Member of the Institution of Electrical Engineers in 1935 and for the 1940-41 session of that Institution he was chairman of its Wireless Section Committee.

Kent Works Manager

Following the recent retirement from active duty of Mr. J. Horridge on medical grounds, the appointment of Mr. J. F. Willsher as general works manager of George Kent Ltd. has been announced.

Mr. Willsher joined the company in 1947 on his release from the Army with the rank of Captain; in 1951 he was appointed production controller and a year later production manager. In 1955 he was appointed manager of the Instrument Division, a post he held until taking over his present position.

Mr. Willsher served on the Council of the Luton Management Association for six years and is now a representative member of the local branch of the British Institute of Management.

Mr. J. Sim

Mr. John Sim has been appointed general manager of Westool Ltd., St. Helen's Auckland, Co. Durham.

Mr. Sim received his engineering training with Vickers-Armstrong Ltd. and was manager of Vickers Eastern Ltd. who sold and serviced Vickers Group products in South East Asia until 1951, when he returned to England to become sales manager of Oliver Pell Control Ltd. and The Varley Magnet Company, of Woolwich.

New Appointments in Crompton Parkinson Group

Mr. A. E. Gregg, Assoc.M.C.T., A.I.E.E., has been appointed general manager of F. & A. Parkinson Ltd., Guiseley, one of the companies in the Crompton Parkinson Group. Mr. Gregg joined the company in 1936, and was formerly product manager for motors at Guiseley, a position he assumed in 1952 after a period as assistant product manager. Mr. Gregg was also general manager of the Overseas Works Division. He has twice been a member of the Junior Board and was chairman on both occasions.

The new product manager for Guiseley motors is Mr. J. C. Mansfield, B.A., who was formerly assistant product manager and who joined the company in 1957. Mr. Mansfield is at present serving on the Junior Board.

Mr. P. G. Smyrk

Mr. P. G. Smyrk joined the board of Johnson, Matthey & Co. Limited on the 1st February, 1959, and was appointed a joint managing director of the company from that date.

Mr. Smyrk had hitherto been the manager of the Export Division of the company, and a director of several of its overseas subsidiaries.

New S.T.C. Executive Appointments

Mr. A. McVie, B.Sc., A.C.G.I., formerly general commercial manager of Standard Telephones and Cables Limited, has been appointed general manager (overseas).

Mr. A. G. Slemeck, B.A. (Oxon.), who was formerly commercial manager (export) has been appointed to succeed Mr. McVie as general commercial manager at S.T.C.'s headquarters at Connaught House, Aldwych, London, W.C.2.

Presentation to Mr. S. F. Steward

The chairman of Lancashire Dynamo Holdings Limited, Col. G. S. Marston, D.S.O., M.C., made a presentation recently on behalf of his fellow directors to Mr. S. F. Steward, C.B.E.

Col. Marston stated that the presentation expressed the good wishes of the

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Lancashire Dynamo Group to Mr. Steward on taking up his new appointment as director-designate of B.E.A.M.A.

Mr. E. K. Cole Elected Honorary Member of Brit. I.R.E.

The Council of the British Institution of Radio Engineers announces that Mr. Eric K. Cole, C.B.E., is to be elected an honorary member of the Institution in recognition of his services to the radio and electronics industry and profession.

Mr. Cole, who is chairman and managing director of the firm bearing his name, which he founded in 1926, has for many years taken a prominent part in the work of the Radio Industry Council and other industry bodies.

Lord Halsbury to be Vice-Chairman of the Lancashire Dynamo Group

The Earl of Halsbury has been invited by the directors of Lancashire Dynamo Holdings Limited to join the board of the company as vice-chairman in April, 1959, by which date the Earl of Halsbury will have relinquished his appointment with the National Research Development Corporation.

New Ekco Press Officer

E. K. Cole Ltd. announce the appointment of Mr. Frank H. Spurling as press relations officer from 1st February. He was previously in charge of the technical sales writing section of the Ekco Publicity Department, which he joined in 1951.

As press officer, Frank Spurling will be responsible for all Ekco press liaison, including the Radio and Television and Heating Divisions of E. K. Cole Ltd. and the wholly-owned Ekco subsidiaries, Ekco Electronics Ltd. and Ekco Plastics Ltd. He will operate from the company's head office at Southend-on-Sea: telephone Southend 49491, ext. 15 (day), Wickford 3107 (night).

British Standard for Slotted Grub Screws (B.S.768:1958)

Previously known as 'grub screws', B.S.768 has now been revised and published under the title 'slotted grub screws'. The new edition includes requirements for screws with UNC and UNF threads, as well as for screws with B.S.W., B.S.F. or B.A. threads; but hexagon socket set screws are omitted as these fasteners are now dealt with in B.S.2470, 'hexagon socket screws and wrench keys'.

The opportunity has been taken to include a number of general requirements in accordance with recent British Standards for screwed fasteners. Since the standard now provides for grub screws with unified threads, every effort has been made to ensure that the dimensions and standard types of points do not conflict with those specified in the equivalent American standard.

To assist designers in their choice of size, standard lengths of steel and brass grub screws are specified in an appendix.

Copies of this Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price 4s. 6d. (Postage will be charged extra to non-subscribers.)

Manufacturers' Publications

Centre-line Indicator-controller

This leaflet describes a new instrument incorporating a novel display of the "Desired" and "Measured Values". When the pointer lines up with a fixed datum on the centre line of the scale, the plant is "on control", and any change in this condition is immediately visible, even from distances at which scale graduations cannot be read. Supplied for either on-off or time modulated three-term control.

Circle **1B** *for further details.*

Gas Analysers

This 16-page publication deals with some of the technical problems associated with gas analysis by the thermal conductivity method. It gives performance data on the katharometer and includes notes on the types of measurement available and on the possible sources of error.

Circle **2B** *for further details.*

Tube and Semiconductor Selection Guide

This guide contains indexes of tubes and semiconductor types, tubes for receivers and amplifiers, cathode ray tubes, transmitting tubes, tubes for microwave equipment, industrial tubes and semiconductors. Translations of the text are given in French, German and Italian.

Circle **3B** *for further details.*

Optical Micrometer Theodolite

The optical and moving parts of the instrument are fully enclosed and protected. The open micrometer scale can be read to less than five seconds by estimation. The instrument has been constructed so that it is robust enough to withstand field service conditions in any part of the world.

Circle **4B** *for further details.*

Levelling Outfit

This levelling outfit is applicable for building sites, roads and drainage, etc. Angles can be laid out and measured to an accuracy of 1°, right angles to an accuracy of 5′.

Circle **5B** *for further details.*

Screws, Nuts, Washers, etc.

This catalogue lists the types of instrument screws, gears and components available, and their price.

Circle **6B** *for further details.*

Chart Drive Unit

Part numbers for new and reconditioned electrical and mechanical chart-drive clocks are listed in a table. All clocks are complete with fixing screws and washers and a key is supplied with each mechanical clock.

Circle **7B** *for further details.*

Metallised Paper Capacitors

The metallised varnished paper is wound by standard method. The use of solid impregnant and sealing material results in an assembly capable of withstanding vibration. The temperature range of the capacitors is −55°C to 100°C.

Circle **8B** *for further details.*

Self-aligning Level

In the self-aligning level, the main spirit level vial is replaced by a compensating unit which keeps the line of sight in a horizontal plane. It is only necessary to level the instrument approximately by means of the circular spirit vial provided, when the moving part of the compensator will swing free and become operative.

The level apart from the compensator is generally similar to any other surveyor's level, without its tubular spirit vial.

Circle **9B** *for further details.*

"Autoset" Level

The self-setting level contains an optical stabiliser which maintains a level line of sight when the telescope is tilted. The stabiliser unit contains one fixed prism above two swinging prisms, the suspended prisms being supported on four metallic tapes forming a cross-spring, flexure pivot. The frictionless suspension has a repetition accuracy better than 1 second of arc. The fixed reflector is a roof prism to secure an erect image. The pendulous double reflector changes its angular relation to the optical axis at the same rate as the telescope is tilted, and so maintains the line of sight truly horizontal.

Circle **10B** *for further details.*

Vapour Pressure Thermometers

4 in. and 6 in. dial instruments are described in a recently issued list which has been reorganised to facilitate selection of suitable patterns and ranges.

Circle **11B** *for further details.*

Instrument Lenses

The leaflet deals chiefly with short focal length lenses, but lenses with focal lengths up to 60 in. and diameters as large as 8·5 in. can also be supplied.

Circle **12B** *for further details.*

Molybdenised Lubricants

This publication gives a comprehensive guide to the use of molybdenised lubricants in industry ranging from aircraft to watches and clocks. Details are given of the specification, scientific and technical data and particle size of molybdenum disulphide used in lubricants.

Circle **13B** *for further details.*

Metal Comparator

This provides a rapid means of comparing ferrous metal components against a standard sample. The comparator may be used to discriminate between components of the same physical size, but manufactured from different materials, to check for correct heat treatment, or to indicate variations in the physical dimensions of magnetically similar samples. If provided with "feed-in" and "feed-out" conveyors, and a reject actuator, the instrument can be made fully automatic.

Circle **14B** *for further details.*

Noise Measuring Equipment

The equipment comprises a superheterodyne r.f. receiver incorporating a frequency discriminator in which either amplitude or frequency modulations at r.f., as the case may be, are converted to a corresponding video signal, together with a spectrum analyser which provides means for examining the spectrum of the signal in the range 1-60 kc/s relative to carrier or to 90 kc/s with reduced sensitivity.

Circle **15B** *for further details.*

Glass Thermometers

A 60-page booklet gives full details of the range and accuracy of the various types of glass thermometers available.

Circle **16B** *for further details.*

Mercury-in-steel Thermometers

The instruments described are constructed on the mercury expansion principle. The reasons are given for preferring mercury-in-steel distance thermometers to other types such as ether vapour, alcohol expansion and gas expansion types, etc.

Circle **17B** *for further details.*

Automatic Controllers

Publication No. R30/IP describes air-operated proportional automatic controllers for use in process industries. Details are also given of the measuring units, regulating units and accessories.

Circle **18B** *for further details.*

Digitisers

Digitisers are used for the conversion of analogue information to the digital form. The following leaflets are available on digitising equipment: industrial mechanical digitiser; decoders for digitisers; in-line indicators; digital clock; codes for digitisers; optical resolver, circular gratings for measuring shaft positions; projection in-line indicators; linear mechanical digitiser; optical resolver; amplifiers and stores.

Circle **19B** *for further details.*

Hygrometers

The instruments listed are of three main types:

(a) wet and dry bulb hygrometers
(b) hair hygrometers
(c) Gregory electrolytic hygrometers.

Circle **20B** *for further details.*

Pressure Gauge

The "Ivix" pressure gauge is available in three sizes. The accuracy is $\pm\frac{1}{2}\%$ or $\pm 1\%$ according to the range. For low ranges there is a diaphragm capsule movement, and for high ranges a specially designed Bourdon tube.

Circle **21B** *for further details.*

Indicating and Recording Gauges

Dial gauges, edgewise gauges, disc and roll type chart recorders, liquid gauges, spares and accessories, and measuring units are described in this 58-page booklet.

Circle **22B** *for further details.*

Spectrochemical Analysis

Catalogue CH 402 gives details of direct reading spectrographs, a three-metre-grating polychromator, medium direct readers, fluorite polychromators, and a metal ratio analyser.

Circle **23B** *for further details.*

Synthetic Crystals

Thallium-activated sodium iodide is used for scintillation counting and γ-ray spectrometry. Graphs show the rate of count against pulse height using various sources. A table lists the standard-sized crystals with their sizes and the sizes of their mounts. Brief details are given of crystals for infra-red use.

Circle **24B** *for further details.*

Laboratory Fittings

A comprehensive guide is given in this catalogue to the furniture and fittings required in the modern laboratory. Three main styles of finish are available. Reference is also made to fume cupboards, extraction plants, sink units, apparatus cupboards and service taps and fittings, etc.

Circle **25B** *for further details.*

Stanley Catalogue

The thirty-third "A" edition of the Stanley catalogue includes the following sections: surveying and drawing instruments; drawing office equipment and stationery; mathematical planimeters; integrators, integraph and harmonic analysers; and navigational, thermometrical and meteorological instruments. There is a detailed index.

Circle **26B** *for further details.*

"Bonderizing"

This process for bonding paint to steel is described briefly and details are given of the range of processes and their advantages.

Circle **27B** *for further details.*

Tri-Mor Dense Guncrete

This refractory material is quite plastic when mixed with water and can be applied with a cement gun. It has a low rebound loss when "gunned". In service its behaviour is similar to that of a normal refractory concrete.

Circle **28B** *for further details.*

Audio Oscillator Type 440

This is a resistance-capacitance tuned oscillator of high output and low distortion covering the range 20 c/s to 20 kc/s.

Circle **29B** *for further details.*

Proximity Guard System Type 144

This system has been developed in order to safeguard two or more overhead tower cranes from collision.

Circle **30B** *for further details.*

Noise Generator Type 122

This instrument is for determining the noise factor of receivers. The output impedance is 71 ohms and noise factors up to 60 may be measured.

Circle **31B** *for further details.*

Hydraulic Variable Speed Gears

The gears are variable with either a combined handwheel speed indicator control or with a handwheel control and separate speed indicator.

Circle **32B** *for further details.*

Springs

One catalogue is a guide to the design and application of the Tensator spring as a constant torque long running motor. Preliminary design data are given for motor springs.

The second catalogue is a guide to the design and application of the Tensator extension spring, and gives preliminary design data for extension springs.

Circle **33B** *for further details.*

Components

The latest issue of leaflets give data on the following components: d.c., synchronous, induction and servo-motors; magnetic record/reproduce head; pressure/shaft output transducers; slide-wire potentiometer, and klystrons.

Circle **34B** *for further details.*

Power Supplies

Details are given of two stabilised d.c. power supplies for laboratory use and for driving balanced d.c. amplifiers, and also a variable power supply which is unstabilised and suitable for laboratory use.

Circle **35B** *for further details.*

Motor Speed Controls

These devices provide adjustable speed operation of motors from standard a.c. mains supply.

Circle **36B** *for further details.*

Automatic Voltage Regulator

Type TCVR is a three-phase, high-speed distortionless servo-mechanical automatic voltage regulator incorporating over and under voltage protection and marginal testing facilities.

Circle **37B** *for further details.*

Electronic Process Timers

The data sheet describes three types of timer; process timers, delay switches and cyclic timers and presents information regarding their characteristics in tabular form.

Circle **38B** *for further details.*

Induction Digitiser

This is a rotary encoder which can be used to give a representation of the angular position of a shaft. Two types are described in the leaflet. The first has an output of five binary digits, the second gives a five digit cyclic binary coded decimal output.

Circle **39B** *for further details.*

Valve Data

This reference brochure gives abridged data for all the company's valves. The valves are classified under rectifiers, germanium rectifiers, triodes, tetrodes, thyratrons, voltage stabilisers, klystrons, magnetrons, travelling wave tubes, etc.

Circle **40B** *for further details.*

Solenoid Actuated Valves

The SGA series of solenoid actuated valves are 4-way operating valves employing a corrosion resistant steel spool and sleeve as the valving element. The range of operating pressure is from atmospheric to 250 p.s.i.

Circle **41B** *for further details.*

4-way Pilot-operated Spring Return Valves

These valves are for control of double-acting cylinders. Pressure is always on one side of the piston with the other side exhausted. The piston comes to rest at the extreme end of its stroke. Airline filters and lubricators should be installed ahead of each valve, and lubrication is important.

Circle **42B** *for further details.*

Constant Force, Constant Torque Spring

This spring is capable of long extensions and large numbers of revolutions, and its energy is released at a constant rate. Positive and negative force/distance gradients can also be achieved.

Circle **43B** *for further details.*

Induction Flowmeter

This flowmeter can handle liquids which are electrically conductive, the minimum conductance being 100 μ mhos/cm^3.

The pipeline is completely unrestricted, there are no moving parts, turbulence and laminar flow of liquids, and viscosity and temperature changes do not affect its functioning or accuracy. Slurries and pastes can be handled, also liquids bearing solid lumps.

Circle **44B** *for further details.*

Circle 63 for further information

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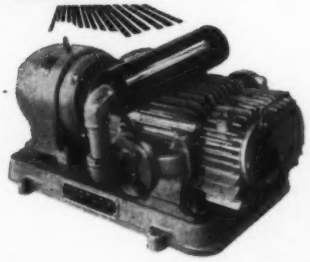

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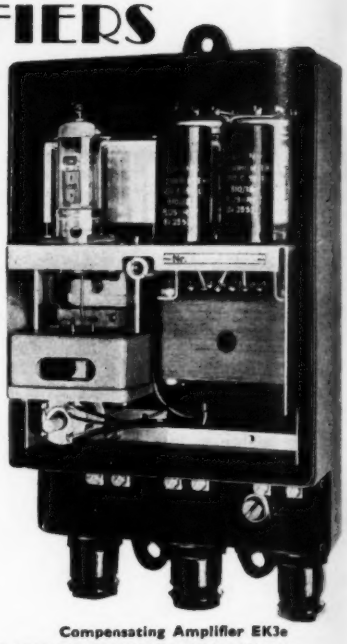

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Supplying the operating current for bridge circuits to which moving coil instruments are connected.

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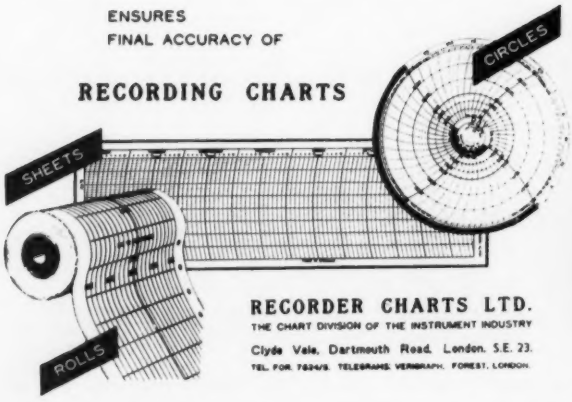

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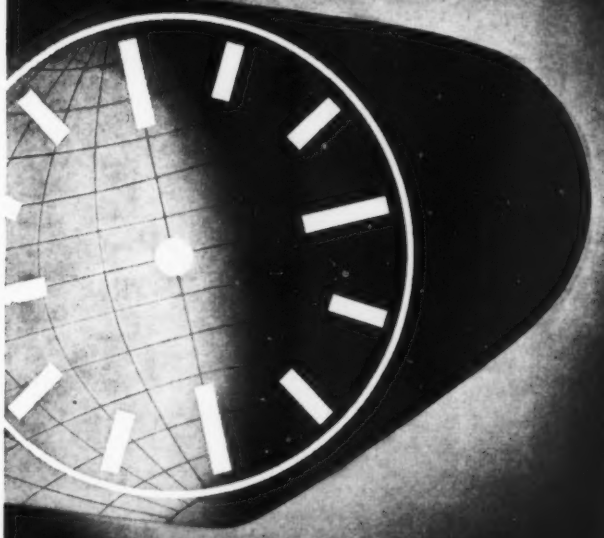

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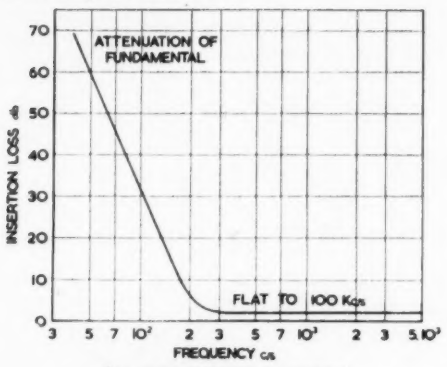

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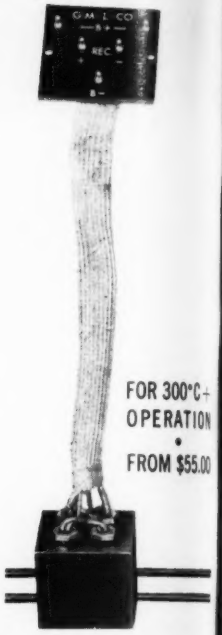

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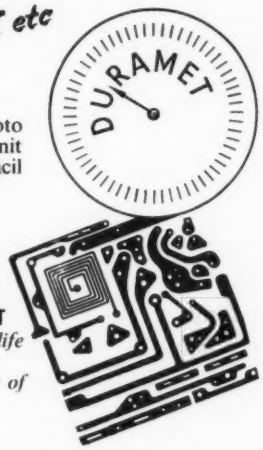

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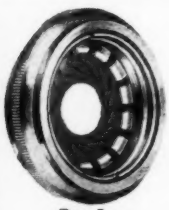

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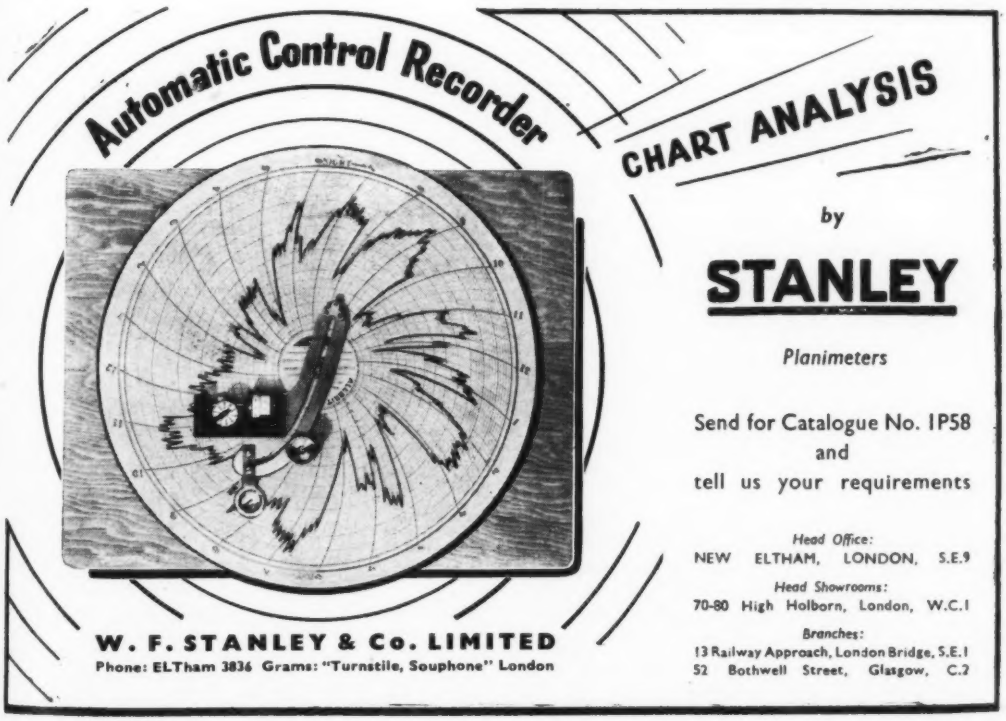

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